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ABSTRACT

This syllabus contains 10 modules that satisfy the one-unit requirement for technology education to be completed by the end of Grade 8 in New York. An introduction provides information on its use. Suggested content outlines of the modules follow. Module components include suggested teaching time; overview; enabling vocabulary; major concepts; performance objectives/supporting competencies; suggested instructional strategies; and suggestions for modifying instructional techniques or materials for handicapped students. Module titles are as follows: Getting to Know Technology; What Resources Are Needed for Technology; How People Use Technology to Solve Problems; Systems and Subsystems in Technology; How Technology Affects People and the Environment; Choosing Appropriate Resources for Technological Systems; How Resources Are Processed by Technological Systems; Controlling Technological Systems; Technology and Society: Now and in the Future; and Using Systems to Solve Problems. A glossary of terms is provided. Twenty-five model technology learning activities (TLAs) are included. Components are completion time; major concepts; overview; equipment and supplies; procedure; constants for infusion into the TLA; background references and resources; examples of evaluation; and appendixes with any necessary other materials. A final section of the manual, called technology learning briefs, contains 99 ideas for students. These present a problem, a brief, and constraints to produce an optimal solution. (YLB)

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TECHNOLOGY EDUCATION
INTRODUCTION TO TECHNOLOGY

GRADES 7&8

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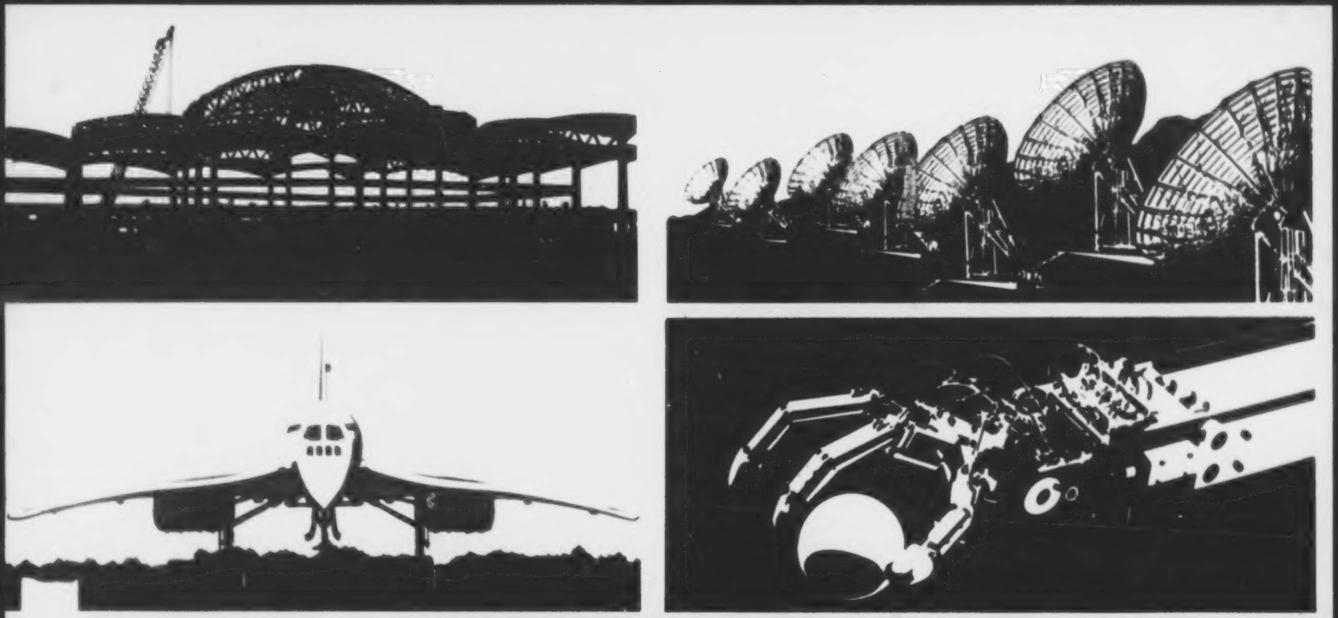

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THE STATE OF LEARNING

The University of the State of New York
The State Education Department
Division of Occupational Education Programs
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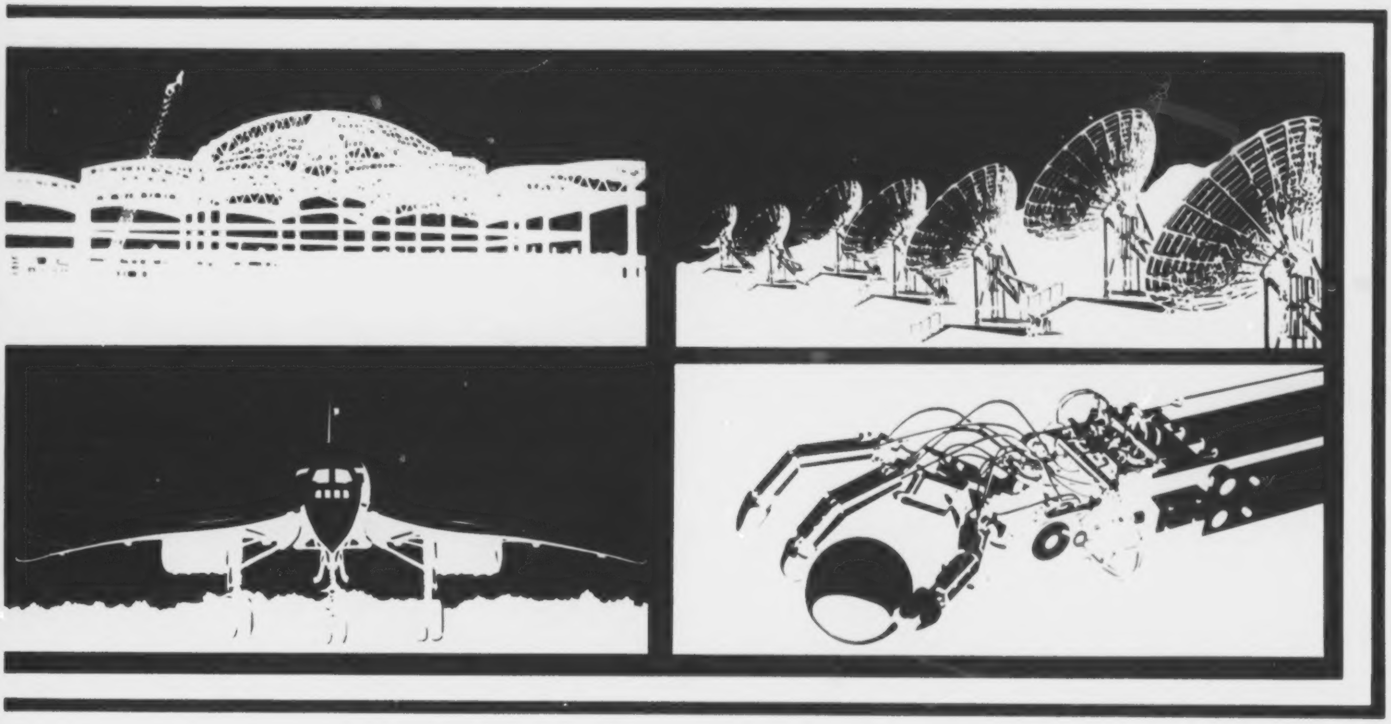

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SCOPE

The modules that compose Introduction to Technology satisfy the one-unit requirement for Technology to be completed by the end of Grade 8.

STATEMENT OF PURPOSE

The progress of the human race has always been directly linked to the development and management of technology. Although technology has been a powerful force in the history of humankind since prehistoric times, it has never been as pervasive an influence on human culture as it is today.

The study of technology has become an integral part of the total school curriculum. Introduction to Technology will emphasize that people must develop and control technology responsibly, and that people have the capabilities to determine how technology can be applied to their benefit. Through the introduction of a simple input-process-output systems model, concepts that are generic to all technological systems will become familiar.

Many of the issues confronting people involve technological interactions. This integration of technology into society creates complexity and demands that we become technologically literate. Our quality of life can be preserved and improved if we recognize and study how our ecological and technological systems interact. Fundamental education in our society should impart an understanding of the possibilities and limitations of technology in order to assist future citizens to make intelligent decisions and to instill in them a sense of environmental and social responsibility. The control of technology requires knowledge, awareness, decision making, and leadership.

DESCRIPTION

Introduction to Technology is a course of study designed to enable seventh and eighth grade students to understand the concepts that underlie technological systems. Students will learn about the influence of technological systems on their total lifestyle, including home, school, and the world of work. The course of study is for children generally between 11 and 14 years of age. According to learning theorists, the majority of children in this age group will benefit educationally from concrete experiences which involve a variety of senses.

With the foregoing thoughts in mind, the appropriate learning environment must take into account students' experiential levels in terms of psychomotor skills and cognitive stages of development. This course of study has been developed with the expectation that instruction will be provided through hands-on, laboratory-based activity. The use of modern tools and machines is an excellent method of providing children with the successful, creative experiences that help build the skills and confidence needed to live in an ever-changing environment.

In Introduction to Technology, students learn about the social forces that make technology such a pervasive part of our lives. Through a study of the resources which are generic to all technologies, and a focus on how these are combined in technological systems, students were provided with conceptual tools that can be useful in solving technological problems in three aspects of technology: biologically related technology, information/communication technology, and physical technology. Students further their understanding of technology as they study the ways that human beings combine the resources of technology to create technological systems.

Students then address additional generic technological concepts such as the methods that people can use to control technological processes, technological career opportunities, and other personal and societal implications of technology.

Students will encounter a wide variety of technical processes, monitor those processes, and use feedback to control the operation of technological systems. The syllabus requires the students to use the computer for accessing data, controlling technical processes, record keeping, computerized decision making, and word processing. The major outcome of this portion of the technology program is an ability for students to synthesize and apply their new technological literacy to the solution of problems through the design, development, operation, and maintenance of systems in each of the aspects of technology.

THE LEARNING ENVIRONMENT

Introduction to Technology is a program which stresses application of theoretical concepts to the solution of practical problems. **This course is designed to be taught through activities which should be 75 percent hands-on, "design and construct" experiences.** The learning environment should be a technology laboratory, equipped with traditional and modern technological tools, machines, and devices, within which all instruction should occur. The instruction may be supplemented by field visits, community-based activities, and use of land laboratories. A guide to planning technology facilities is available from the Division of Occupational Education Programs.

INSTRUCTIONAL OVERVIEW

The Technology Education program emphasizes hands-on activities and the development of mental process skills such as: creative thinking, decision making, critical thinking, and problem solving. This curriculum is designed with alternative strategies for teachers to use in the presentation of materials and permits a variety of student responses. Strategies offered have been designed so that the important cognitive processes will be integral parts of student activity.

Opportunities will be provided within the structure of the curriculum for children to learn from their mistakes; to solve problems through analysis, modeling, trial and error elimination, and other techniques; and to propose creative, innovative, nontraditional solutions to technical problems.

The curriculum may be presented one module at a time or a thematic approach may be used. The thematic approach can focus on a theme (for instance, information/communication) to connect the content and performance objectives of several modules. This strategy would provide students the opportunity to complete more sophisticated activities and address technology as the synergistic system that it is. Themes based upon biologically related technology and physical technology can also be used to tie together the content of several modules. This approach can provide balanced treatment of each of the three aspects of technology so long as the activities address every performance objective of the modules included within the theme.

USE OF THIS SYLLABUS

A major feature of the syllabus is its format which includes performance objectives and supporting competencies in each module. Underneath each performance objective are specific supporting competencies which must be met for a student to achieve the expected objective. The performance objectives/supporting competencies establish the student outcomes, serve as criteria for the teacher in selecting strategies, and guide evaluative measures. Instructional strategies should be planned to help students reach all objectives and all competencies.

Each module includes a list of enabling vocabulary to assist the teacher and students with new technological terms, and key ideas are clarified by a list of major concepts to be addressed. In addition, each module includes a list of suggested instructional strategies with variations of the strategies to assist students with handicapping conditions. Teachers are encouraged to select and plan strategies based on student needs and resources available. Once a strategy is selected, it should be integrated into a detailed Technology Learning Activity (TLA) with supporting lesson plans.

TECHNOLOGY LEARNING ACTIVITIES (TLAs)

One of the more unique aspects of the Technology Education program has been the creation of Technology Learning Activities, or TLAs. TLAs provide teachers with laboratory activities which can be used to enable students to meet the performance objectives and to communicate the major concepts identified in each curriculum module. In addition to being used by teachers as actual laboratory activities, TLAs serve as models for teachers, who are encouraged to develop their own.

Because technology itself is so pervasive, the subject can serve to provide genuine interdisciplinary connections to other school subjects, the world of work, and life's experiences. Through the identification of ten "constants" in every TLA, transfer of learning is facilitated. As a result, Technology Education can serve to integrate the knowledge provided by the various disciplines.

TLAs will inspire students to inquire, be productive, and respond to their environments as active participants. It is anticipated that students will develop leadership skills and a more positive sense of the technological society.

CONSTANTS IN TECHNOLOGY EDUCATION

Technology Education provides links between theoretical concepts and their practical applications. As an integrating discipline, emphasis is placed on establishing interdisciplinary connections.

The following "constants" are perceived as occurring throughout the entire curriculum document and, therefore, merit continual attention. It is recommended that these constants be addressed wherever possible. Technology Learning Activities provide the best vehicle through which the constants can be delivered.

1. **SYSTEMS OF TECHNOLOGY:** All technologies should be interpreted as comprising systems and subsystems. Systems models should be used to describe technical operations wherever possible.
2. **MATHEMATICS CONCEPTS:** Activities suggested in this syllabus will be used to reinforce mathematics concepts.
3. **SCIENCE CONCEPTS:** Activities suggested in this syllabus will be used to reinforce science concepts.
4. **AWARENESS OF HUMAN ELEMENTS OF TECHNOLOGY – SOCIETAL IMPLICATIONS:** The pervasive presence of technology can be used to provide many illustrations of its impact on our personal and professional lives, our institutions, and our culture. Impacts of technology on all people, including those with handicapping conditions, and on the environment should be addressed.
5. **COMMUNICATIONS SKILLS:** Activities in Introduction to Technology should be used to reinforce youth leadership capabilities and skills in communicating ideas and information through the development of the student's spoken and written technical vocabulary. Activities can contribute to the development of skill in reading technical vocabulary and in interpreting graphic information.
6. **SAFETY AND HEALTH:** Safety awareness, protection, and safe practice (prevention of accidents) as well as health awareness and health practice (prevention of illness) should be developed and reinforced in the laboratory, home, and workplace.
7. **PSYCHOMOTOR SKILLS:** The Technology program must entail laboratory-based, manipulative experiences involving tools, materials, and processes. These activities should lead to the development and refinement of technical and psychomotor skills.
8. **CAREER-RELATED INFORMATION:** Information about career opportunities should be infused wherever appropriate. It should be stressed that technology has affected all jobs, not just those in "high-tech" areas. The student should be made aware at all times of attributes needed for employment. These attributes include dependability, honesty, punctuality, reliability, responsibility, ability to work with others, pride in work, self-awareness, self-reliance, and self-worth.
9. **CREATIVE PROBLEM SOLVING:** Opportunities for student creativity and initiative should be provided through the use of a problem-solving approach to the activities.
10. **TRANSFER OF LEARNING:** The major concepts identified at the beginning of each module have applications in a wide variety of circumstances transcending the specific activity within which they are addressed. Transfer of learning implies that specific knowledge and skills learned through the Technology Learning Activity (TLA) can help the student interpret other new experiences which may involve related concepts.

GENERAL INSTRUCTIONAL STRATEGIES

As previously indicated in the instructional overview, the Technology program shall be taught through hands-on, applied activities, utilizing materials, tools, instruments, equipment, and procedures safely in a laboratory. It is expected that a minimum of 75 percent of the instruction will be accomplished through hands-on activities.

A variety of instructional strategies may be employed by teachers to support instruction, to link the study of technology to other disciplines, and to reinforce basic skills through practical application.

BUILDING PROJECTS: Develop students' cognitive, psychomotor, and affective skills. Use modern tools, materials, processes, and component parts.

GAMING: Develops students' interest in learning about technology. Use question-answer, game board, and computer games to motivate students in modeling applications of technology in the real world.

RESEARCHING: Develops students' understanding of new tools, materials, processes, and socio-cultural problems. Use investigatory tasks that involve technical and socio-cultural endeavors.

VISUALIZATION: Develops students' understanding of the abstract aspects of technology; visualization also provides a broad view of technology in general. Use audio-visual aids such as films, slides, movies, etc.

CONSTRUCTION OF SCALE MODELS: Develops students' understanding of past, present, and future technologies. Use low-cost materials to construct working models that depict technical functions of tools, machines, and devices.

PRESENTATION AND DEMONSTRATION: Develop students' vocabulary to include new technological terms and help students express their knowledge of the subject. Use class presentations as a form of student information sharing.

ROLE PLAYING: Develops students' understanding of people and their use of technology around the world in business/industry and everyday life. Use classroom settings to illustrate different roles people assume in the world. The inclusion of role models who are in occupations that are nontraditional to their sex (including historical role models) will help to break down stereotypical notions about certain careers. Active role models as mentors, presenters, and consultants can help the teacher provide encouragement and support to students, particularly those who shy away from certain activities because of stereotypical notions or lack of prior experience.

WRITING: Develops students' thinking about technology in the past, present, and future. Use assigned technical reports, scenarios, and forecasts.

DISCUSSION: Develops students' awareness of new technologies and technological issues. Use formal and informal conversations; hold subject matter discussions to reveal student's knowledge of technology.

READING: Develops students' ability to comprehend technological subject matter. Use books, magazines, newspapers, and related technological literature to create a technology bookshelf and bulletin board.

SIMULATION: Develops students' understanding of biotechnical, communication, construction, manufacturing, and transportation systems. Use activities to create learning environments which may reflect high technology industries, rapid transit systems, etc.

EXPERIMENTATION AND PROBLEM SOLVING: Develop students' ability to understand the process which is critical to developing new technology. Use laboratory activities which involve discovery/inquiry tasks.

YOUTH LEADERSHIP ACTIVITIES: Develop student leadership abilities to participate in today's technological society. Develop communication, decision-making, problem-solving, and management skills, the ability to motivate others and to understand human relationships. Use appropriate youth leadership activities, sponsored by DECA, FBLA, FFA, FHA, HOSA, TESA and VICA.

SPECIAL PROJECTS: Community-based service projects, homework, research reports, visitations, and field trips can supplement classroom instruction.

SPECIAL POPULATIONS PROVISION

The majority of students with handicapping conditions have, by definition, the intellectual capacity to master the curricular content requirements for a high school diploma. Such students must attain the same academic standards as their nonhandicapped peers in order to meet these requirements. Students with handicapping conditions are provided instruction in a wide variety of settings from regular education classes to special education classes. Teachers providing instruction through these modules should become aware of the needs of those students with handicapping conditions who have been appropriately placed within their classes. Instructional techniques and materials must be modified if necessary so that the information can be attained by such students.

Each module includes suggestions for modifying instructional strategies and materials to meet the needs of the handicapped. These possibilities and suggestions are intended to provide teachers with a few examples and should be viewed as a base from which teachers in both regular and special education can develop additional strategies.

YOUTH LEADERSHIP SKILLS

Development of leadership skills is an integral part of occupational education in New York State. The New York State Education Department policy is that: "Each education agency should provide to every student the opportunity to participate in student leadership development activities. All occupational education students should be provided the opportunity to participate in the education activities of the student organization(s) which most directly relate(s) to their chosen instructional program."

Leadership skills have been incorporated into the New York State occupational education curricula to assist students to become good citizens with positive qualities and attitudes. Every individual should develop skills in communication, decision making/problem solving, human relations, management, and motivational techniques.

Leadership skills may be incorporated into the curriculum as competencies (performance objectives) to be developed by every student or included within the suggested activities. Teachers providing instruction through occupational education curricula should familiarize themselves with the competencies. Assistance may be requested from the state advisor of the occupational student organization related to the program area.

Students who elect to become active members of one of the student leadership organizations chartered by the New York State Education Department have the advantage of a practical forum to demonstrate leadership skills in an action-oriented format and have the potential for recognition of their achievement at the local, state and national levels.

CONTENT OUTLINES

These outlines suggest content that might be used to accomplish the goals of the modules.

GETTING TO KNOW TECHNOLOGY (T-1)

I. People study technology
  A. Physical technology
  B. Biologically related technology
  C. Information/communication technology

II. Technology satisfies human needs and wants
  A. Physical technology
    1. Transportation
    2. Production
      a. Manufacturing
      b. Construction
  B. Biologically related technology
    1. Food processing
    2. Medicine
    3. Agriculture
  C. Information/communication technology
    1. Graphic communication
    2. Electronic communication
    3. Photographic communication

III. Technology has evolved over many years
  A. Early technologies
    1. Primitive tools
    2. Fire
    3. Wheel and axle
  B. Developments and innovations
    1. Metallurgy
    2. Electricity
    3. Genetic engineering
  C. Technological shifts and career changes
    1. Agriculture
    2. Industrial
    3. Information

IV. Technological change affects people's routines
  A. Technological time line
    1. Stone Age
    2. Agricultural Age
    3. Industrial Age
    4. Computer Age
  B. Exponential growth of technology
    1. Transportation - horse and buggy to space shuttle
    2. Information - abacus to computer
    3. Production - crafts to automation

WHAT RESOURCES ARE NEEDED FOR TECHNOLOGY (T-2)

I. Technological development utilizes resources
  A. People
    1. Labor
    2. Management
    3. Consumer
  B. Information
    1. Processes
    2. Techniques
    3. Data
  C. Tools and machines
    1. Hand tools
    2. Manual machines
    3. Automated machines
  D. Materials
    1. Natural
    2. Processed
    3. Renewable and nonrenewable
    4. Synthetic
  E. Capital
    1. Means of exchange
      a. Barter
      b. Money
      c. Stocks and bonds
    2. Investments
      a. Equipment
      b. Facilities
      c. Land
  F. Energy
    1. Forms
      a. Radiant
      b. Mechanical
      c. Electrical
      d. Chemical
      e. Thermal
      f. Light
      g. Magnetic

2. Sources
   a. Human and animal muscle
   b. Fossil fuels
   c. Flowing water and tides
   d. Solar
   e. Wind
   f. Nuclear
   g. Geothermal
   i. Biomass

G. Time
  1. Human limitations
  2. Natural constraints
  3. Importance of time, in:
     a. Agricultural age
     b. Industrial age
     c. Information age

II. Technology requires skills in using the resources
  A. Selecting Resources
  B. Processing Resources
    1. Materials
       a. Growing, harvesting, and mining raw materials
       b. Converting raw materials to basic industrial materials
       c. Processing materials
    2. Energy
    3. Information

III. Technology is influenced
  A. Culture of society
    1. Developing countries
    2. Beliefs and/or attitudes
  B. Resource availability
    1. Renewable
    2. Climate/geographic region
    3. Alternatives

HOW PEOPLE USE TECHNOLOGY TO SOLVE PROBLEMS (T-3)

I. There are various methods used to solve problems
  A. Formal methods
    1. Systems approach
    2. Scientific method
  B. Other methods
    1. Trial and error
    2. Role playing
    3. Simulations
    4. Modeling
    5. Insight

II. Problem solving includes design and implementation
  A. Design concepts
    1. Aesthetic qualities
    2. Ergonomics
  B. Implementation
    1. Experimentation
    2. Evaluation and modification

III. Problem solving includes the generation of alternative ideas
  A. Brainstorming, ideation, imagineering
  B. Forced connections

IV. Optimization is part of the problem solving techniques
  A. Trade-offs
  B. Compromise

V. Problem solving includes many techniques
  A. Functional models
    1. Scale models
    2. Prototypes
    3. Dioramas
  B. Computer simulation
  C. Technical illustrations
    1. Sketching
    2. Orthographic
    3. Pictorial
    4. Schematic
    5. Computer-aided design/drafting

VI. Constraints and limitations to technology
  A. Natural constraints
    1. Scientific principles
    2. Resource limitations
  B. Human limitations
    1. Values
    2. Attitudes

SYSTEMS AND SUBSYSTEMS IN TECHNOLOGY (T-4)

I. People design systems to satisfy needs and wants
  A. Extend human capabilities
  B. Environmental needs and concerns
    1. Clean air
    2. Clean water

II. Systems combine resources
  A. Types of systems
    1. Natural
    2. Human-made technological systems
      a. Biotechnical systems
      b. Production systems
      c. Information/communication systems
      d. Transportation systems
  B. Systems theory
    1. Components
      a. Command input
      b. Resource inputs
      c. Process
      d. Feedback loop (monitor, compare, adjust
      e. Output(s)
    2. Relationship of components to each other

III. The systems model as an analytical tool
  A. Analysis of existing systems
  B. Adaptation of existing systems
  C. Generic analysis of new systems
  D. Symbolic representation of systems

IV. Sub-systems combine to produce more powerful systems
  A. Systems
    1. Transportation
    2. Artificial climate control
  B. Subsystems
    1. Cars, trains
    2. Heating, cooling

V. New technologies may result when combining existing technologies
  A. New, more powerful technologies
  B. Confluence of systems
  C. Emerging technologies

VI. Feedback helps to control technological systems
  A. Open loop (no feedback loop)
    1. Programmed control
    2. Manual control
  B. Closed loop (feedback loop)
    1. Monitor
    2. Comparison
    3. Adjustment

HOW TECHNOLOGY AFFECTS PEOPLE AND THE ENVIRONMENT (T-5)

I. Technology should be adapted to the human user
  A. Human needs
    1. Shelter
    2. Food
    3. Clothing
  B. Ergonomics
    1. Car seats
    2. Tool handles
  C. Social impacts of technology
    1. Work schedules
    2. Medical advancements
    3. Movements of goods and people
    4. Expanded leisure time

II. Technology should be adapted to the environment
  A. Natural environment
    1. Solar energy in desert areas
    2. Hydroelectric in mountainous regions
  B. Human-made environment
    1. Hospital operating rooms
    2. Dust free computer assembly facilities

- C. Interaction of human-made and natural environment
  - 1. Acid rain
  - 2. Construction of homes in areas prone to flood

III. Technology produces many outputs
- A. Expected
- B. Unexpected
- C. Desired
- D. Undesired
- E. Combinations (*e.g.*, electrical energy generating facility)
  - 1. Expected/desired - electrical energy
  - 2. Expected/undesired - smoke
  - 3. Unexpected/desired - greater efficiency than expected
  - 4. Unexpected/undesired - acid rain
- F. People control technology to be:
  - 1. Positive
  - 2. Negative

IV. Technology can solve or create problems
- A. Technology can satisfy needs
  - 1. Great inventions (automobile)
  - 2. Great processes (mass production)
  - 3. Great materials (silicon chip)
- B. Technology can create problems
  - 1. Pollution (automobile)
  - 2. Unemployment (robots)
  - 3. Catastrophes (nuclear war)
  - 4. Global imbalance (agriculture)
  - 5. Technological mismatches (typewriter keyboard)

CHOOSING APPROPRIATE RESOURCES FOR TECHNOLOGICAL SYSTEMS (T-6)

I. Resources
- A. People
- B. Information
- C. Materials
- D. Tools and machines
- E. Capital
- F. Energy
- G. Time

II. Choosing resources
- A. Identified goals
- B. Processes available
- C. Constraints and limitations
  - 1. Human
  - 2. Natural

III. Combining of resources
- A. Optimization
- B. Compromises and tradeoffs
  - 1. Availability
  - 2. Renewability
  - 3. Risk of depletion
  - 4. Cost to obtain or process
  - 5. Appropriateness
  - 6. Safety of handling
  - 7. Environmental impact
  - 8. Profitability

IV. Choosing materials
- A. Mechanical properties
  - 1. Ductility
  - 2. Brittleness
  - 3. Plasticity
  - 4. Elasticity
  - 5. Strength
    - a. Compression
    - b. Tension
    - c. Torsion
    - d. Shear
  - 6. Toughness
  - 7. Hardness
- B. Electrical properties
  - 1. Conductors
  - 2. Insulators
- C. Magnetic properties
- D. Thermal properties
- E. Optical properties

V. Choosing computer software
- A. Word processing
- B. Database management
- C. Graphics
- D. Telecommunication
- E. Specialized applications

HOW RESOURCES ARE PROCESSED BY TECHNOLOGICAL SYSTEMS (T-7)

I. Processing of resources
  A. Materials conversion
    1. Combining
    2. Separation
    3. Forming
    4. Conditioning
  B. Energy conversion
    1. Types of energy
      a. Potential
      b. Kinetic
    2. Conservation of energy
    3. Sources of energy
      a. Human and animal muscle
      b. Solar
      c. Chemical
      d. Gravitational
      e. Geothermal
      f. Nuclear
    4. Energy conversions (examples)
      a. Chemical to mechanical
      b. Thermal to mechanical
      c. Chemical to thermal
      d. Mechanical to electrical
      e. Electrical to light
      f. Electrical to sound
      g. Matter to energy
  C. Information conversion
    1. Information processing
      a. Collecting
      b. Recording
      c. Classifying
      d. Calculating
      e. Storing
      f. Retrieving
    2. Communication

II. The computer as a tool
  A. Information processing
  B. Communication
  C. Control

CONTROLLING TECHNOLOGICAL SYSTEMS (T-8)

I. Open-loop vs closed-loop control
  A. Open-loop systems
    1. Can be program controlled
    2. Unable to adjust to changing conditions
  B. Closed-loop systems
    1. Use feedback to adjust to changing conditions
    2. Adjustment can be human or automatic

II. Elements of the feedback loop
  A. Sensor
  B. Comparator
  C. Controller

III. Sensors
  A. Electrical
  B. Electronic
  C. Mechanical
  D. Optical
  E. Thermal
  F. Magnetic

IV. Comparators
  A. Mechanical
  B. Electrical
  C. Electronic

V. Controllers
  A. Electrical
  B. Mechanical
  C. Electro-mechanical
  D. Pneumatic
  E. Hydraulic

VI. Program control
  A. Timers
  B. Computer
  C. Feedback and program control combined

VII. Computer control
  A. Open loop
  B. Closed loop

TECHNOLOGY AND SOCIETY: NOW AND IN THE FUTURE (T-9)

I. Assessment of technological systems
  A. Analyzing the systems model output
    1. Impacts on people
    2. Impacts on society
  B. Technological evolution
    1. The future world
    2. Emerging technologies

II. Impacts on work, job opportunities, and careers
  A. Constant change due to the evolution of technology
  B. Adaptability
    1. Flexible attitudes
    2. Transferable skills
  C. Development of future industries
  D. Leadership and social skills
  E. Careers with higher levels of responsibility
    1. Technician
    2. Engineer
    3. Technology Education teacher

III. Scope of technological impacts, perceived or actual
  A. Personal
  B. Local
  C. National
  D. Global

IV. The interdependent world
  A. Consumption of resources
  B. Competition for jobs, markets, and resources

V. Controlling world impacts
  A. United Nations concept
  B. The World Bank
  C. Other international organizations

USING SYSTEMS TO SOLVE PROBLEMS (T-10)

I. Systems model for problem solving
  A. Identify and define problem clearly
  B. Set goal and criteria (desired results)
  C. Generate alternative solutions
  D. Select best solutions (optimize)
  E. Implement the solution
  F. Evaluate actual results and modify if necessary

II. Systems theory
  A. Components
    1. Command input
    2. Resource inputs
    3. Process
    4. Feedback loop (monitor, compare, adjust)
    5. Output(s)
  B. Relationship of components to each other

III. Computers for problem solving
  A. Decision-making tool
  B. Implementation device
  C. Data storage and retrieval

MODULE T-1
GETTING TO KNOW TECHNOLOGY

PREREQUISITES:

None

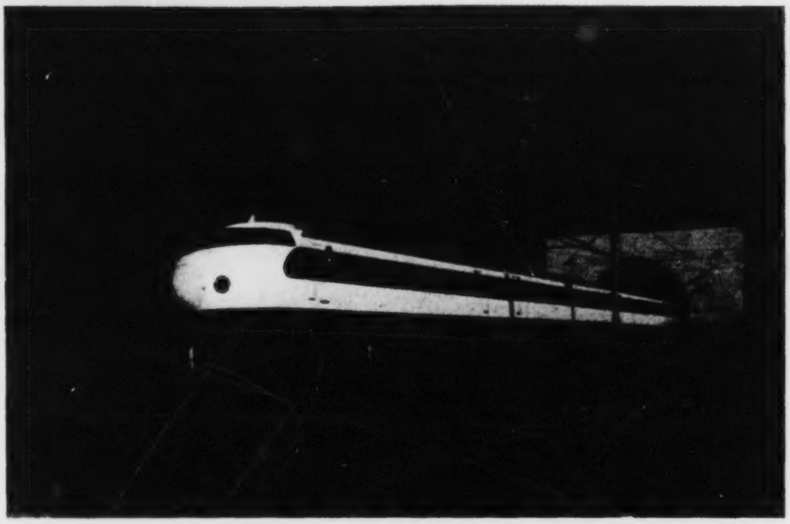
SUGGESTED TEACHING TIME:

3-4 Weeks

15-20 Forty-minute Periods

KAJIMA CORPORATION

KAJIMA CORPORATION



MODULE T-1
GETTING TO KNOW TECHNOLOGY

OVERVIEW OF MODULE

GOAL

In this module the student will examine the historical evolution of technological innovation as a means through which human needs and wants are satisfied.

DESCRIPTION

Throughout the history of people, the complexity of their technology has evolved through three stages: handcraft, mechanization, and cybernation. During the handcraft period, technology was limited in scope so that people could, through experience, amass an understanding of the technological aspects that confronted them on a regular basis. There is no longer any way that individuals living in modern society can assimilate the total technological information base that supports daily life. What can be developed is a general technological literacy that allows people to function intelligently within the complexities of the environment and provide elements of control.

Technological knowledge is developmental in nature and based on the experience of each individual. In this module, students will experience technology in its early forms and study the evolution of technology to its present form. This study of the evolution of technology will include: the study of the past as a means of understanding the present; the study of significant technological developments and inventions; the study of career changes as a result of technological development; and the study of the

technological society. These experiences will be manipulative and will provide students with a technological foundation that can be expanded into the future.

ENABLING VOCABULARY

Definitions will be found in the Technology Education glossary of terms.

AGRICULTURALLY BASED SOCIETY

BASIC HUMAN NEEDS

BIOLOGICALLY RELATED TECHNOLOGY

CAREERS

GENERIC

INDUSTRIALLY BASED SOCIETY

INFORMATION-BASED SOCIETY

INFORMATION/COMMUNICATION TECHNOLOGY

INNOVATION AND INVENTION

MANUAL

MANUFACTURING

NEEDS AND WANTS

PHYSICAL TECHNOLOGY

SIMPLE MACHINES

MAJOR CONCEPTS TO BE DEVELOPED

T-1 A. People study about technology because much of human progress has occurred as a result of technological development.

T-1 B. Work, job opportunities, and careers are in constant change because of the evolution of technology.

T-1 C. People's routines are influenced by technology.

T-1 D. People create and use technology as a means of satisfying basic biological, physical, and psychological human needs and wants.

T-1 E. Information technology satisfies our need to communicate ideas and process information.

T-1 F. Biologically related technology seeks to satisfy our biological needs; it promotes, enhances, and supports the advancement of the improved quality of life.

T-1 G. Physical technologies satisfy many physical needs through construction of shelter, transportation of people and goods, and production of clothing and other necessities.

T-1 H. Complex technologies develop from more simple technologies, and the development is a constantly evolving process.

T-1 I. Technology has existed for over one million years; it is growing at a faster rate today than ever before in history.

T-1 J. The development of technology results in a greater and more rapid production of goods and communication of information.

PERFORMANCE OBJECTIVES/ SUPPORTING COMPETENCIES*

1. Utilizing laboratory-based projects (*e.g.*, timelines, models), the student will demonstrate how the evolution of physical, biologically related, and information/communication aspects of technology led to the shift from an agriculturally based to an industrially based to an information-based society.**

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*All student performance objectives have been written without specific evaluative criteria. It is expected that teachers will specify minimum performance levels consistent with the ability levels of their groups.

**Throughout this curriculum, "aspects of technology" shall be intended to mean biologically related, information/communication and physical technologies.

In order to do this, the student must be able to:
- a. Define an agriculturally based society, an industrially based society, and an information-based society.
- b. Prepare evolutionary timelines, models, or demonstrations.
- c. Use materials, tools, instruments, equipment, and procedures safely in a laboratory.

2. Given a description of the three aspects of technology, the student will give an example from each of the three categories of an application of a modern tool, device, or method which has evolved from simple beginnings, and describe how it has changed daily routines and contributed to human progress.

In order to do this, the student must be able to:
- a. Identify tools in each of the three technologies.
- b. Utilize research skills.
- c. Understand timelines connected to human progress.

3. Given examples of human needs and wants, (biological: hunger, thirst; physical: shelter, clothing, protection; psychological: communication, recreation), the student will research examples of technological innovations from each of the three aspects of technology which satisfy those needs and wants and will model one of these innovations.

In order to do this, the student must be able to:
- a. Research and record data through use of charts, graphs, and drawings.
- b. Differentiate between needs and wants.
- c. Use materials, tools, instruments, equipment, and procedures safely in laboratory.

SUGGESTED INSTRUCTIONAL STRATEGIES

Instructional strategies may be homework assignments, classroom activities or laboratory work. Those strategies to be implemented in the laboratory should be developed according to the Technology Learning Activity (TLA) format. In all cases, a variety of approaches for instruction and evaluation should be used to address the needs of individual students.

1. HUMAN NEEDS: An activity could be developed to show how needs generate technological solutions. Laboratory activities might then be planned to point out how technology has satisfied:
   - a. A human need like shelter, which requires building structures suited to terrain.
   - b. The need to grow and process food.
   - c. The need for security.
   - d. The need for adaptation to minimize disabilities and/or reach potential.

   Based on Maslow's hierarchy of needs, students might engage in construction activities designed to illustrate how technology has helped to satisfy these needs. The need for shelter, for example, might be addressed by building one or more models or actual structures (adobe huts, yurts, igloos, or other appropriate shelters).

   The need for safety might be addresed by constructing a smoke detector or burglar alarm. Needs for social approval are often created by product manufacturers and advertisers. Mouthwash and deodorants are examples. Related activities, therefore, might involve creating a product need through production of a videotaped, photographic, or printed advertisement.

2. Locate on, or add to a floor plan, evacuation routes, location of safety materials, devices, equipment and accessibility accommodations for individuals with physical, visual, or auditory impairments.

3. Develop a timeline which includes significant technological developments.

4. Construct a simple tool or device (*e.g.*, cutting tool, screwdriver, mold for forming materials).

5. Describe the historical development of a given tool or process.

6. Construct a folk toy using traditional tools and methods.

7. Construct an historical model of a machine, fortification, or invention, and identify the use of simple machines.

8. Construct a model from a kit (Fisherteknik, Lego Technik, electronic kits, etc.).

9. Produce a product from native raw materials (from trees, clay, etc.).

10. Use human-made (synthetic) materials and indicate how they have altered our potential.

11. Produce one or more timekeeping devices, such as water clocks, sand clocks, rope clocks, etc.

12. Find newspaper and magazine pictures that illustrate examples of applications of technology and make a technology bulletin board.

13. Construct an arch bridge.

14. Produce a logo to communicate an idea.

15. Construct a branding iron as an example of information technology.

16. List the names and uses of tools and equipment that help fulfill basic human needs during a selected day.

17. Eliminate a given tool (*e.g.*, fork, comb) or innovation (*e.g.*, cassette tape player, videogame, alarm clock) for a series of days, and have students record on tape or paper reactions to the loss.

18. Study historical sites in the community and identify their significance.

19. Visit a technological museum.

20. Amplify the work of a teacher in a different discipline to help teach a concept.

21. Introduce students to "systems" by referring to a student personnel system. The input command, given by the superintendent, is to clean up the laboratory. The process includes all students doing the jobs to which they were assigned, and makes use of resources such as people, energy, tools (like brooms and dust pans), etc. The output is a lab in some state of cleanliness. Feedback is generally provided by the teacher or students who monitor the process and compare desired and actual results.*

22. Collect herbs formerly used as medicines (for healing).

23. Identify all information systems present in the homes of students (*e.g.*, heating system using thermostat, etc.). Indicate how the functions they perform used to be done.

24. Interview a grandparent and/or older neighbor about how things were in the "good old days."

25. Explain a cleanup schedule and responsibilities. Have the students submit job applications and conduct interviews for the positions.*

26. Make a display of the oldest tools that each child has at home.

27. Construct timelines of tools used in the students' community. Relate tools to their historic use and to the present-day industry. Students could interview an older person who actually used the historic tool.

28. Write an advertisement to sell the product that the student made in this or any other module.*

29. Establish and affiliate with an active youth leadership organization to sponsor such activities as debating technological issues, and local officer training.*

30. Purchase and plant trees and shrubs at the school.*

31. Hold a school Technology Fair or Open House.*

32. Sponsor a Technology Quiz Bowl or other learning games to motivate student learning.*

33. Model, demonstrate, or discuss technological contributions made by women and/or members of minority groups.

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*These strategies promote leadership qualities such as communication skills, decision-making abilities, problem-solving abilities, management skills, the ability to motivate others and to understand human relationships.

SUGGESTIONS FOR MODIFYING INSTRUCTIONAL TECHNIQUES OR MATERIALS

Students with handicapping conditions may require additional materials, information, and practice. For example, a student with visual perception or perceptual motor difficulties may be supplied with a drawing or an example, thus easing the creative, adaptive, and mathematical demands of design. Production may proceed from the given drawing or template with supplemental, sequential instruction provided either by audio or video tape or a peer tutor.

Adaptive procedures to develop visual thinking skills using a different approach may include some of the tasks identified below. Specific instruction and criteria may be added based on student needs and laboratory resources.

Suggested Tasks:

1. Given studio proof paper, have the student make silhouettes of hand tools or object parts; or have the student trace the tool or part to produce silhouettes on construction paper.
2. Have the student match silhouettes to the appropriate hand tool or object parts. Emphasize the use of the proper forms. Require the student to repeat the terms.
3. Given geoboard designs in two-dimensional representation (sketches, diagrams, photos), have the student construct models in three dimensions. (Supply geoboards and rubber bands). As visual memory develops, impose a time delay between showing the design and constructing it, thereby increasing the difficulty of the task.
4. Given two-dimensional representation of color cube or marquetry block designs and the required cubes or blocks, have the student construct a model of the design. (Increase difficulty with strategy described above by increasing complexity of design).

Creative strategies in the production phases would involve simplification of the job through task analysis; shorter, sequential assignments; and multiple repetitions. An example is laying out, centerpunching, and lining up a drill. Increased repetitions may not be necessary for all students with educational handicaps. For some there may be a need to develop appropriate skills for group interaction or cues for following directions.

Several general procedures have proven successful with adolescents. One method is to specify the desired behavior and have the student repeat the task statements. Reinforcing desired behaviors either verbally or through other forms of recognition generally increases the frequency of those behaviors. Using graphs, checklists, and charts puts module content in concrete terms and helps make students, and teachers, feel that they are accomplishing given tasks. Learning contracts can also be useful. Concrete goals and structure often help to guide and check progress.

Students who are handicapped and appropriately mainstreamed should be exposed to all of the constants involved in module activites. The complexity of the math and science concepts should be considered, but major adaptations for mildly handicapped students should not be necessary. Different teaching approaches are often the key. Students may benefit from the use of a calculator or measuring devices with adaptations (fractional inches with color codes, large numerical markings, measuring jigs for specific tasks, tape recorded instructions for review or reinforcement, or multisensory approaches to skill acquisition).

There may be a need for vocabulary development for scientific and technological terms. Students with handicapping conditions may benefit from assignments that are segmented rather than assignments that are lengthy. Some students respond positively to concentration on concrete terms as an introduction to understanding abstract concepts. In addition, concrete, manipulative activities will bring terms within the real experiences of all students in class and aid in the development of understanding.

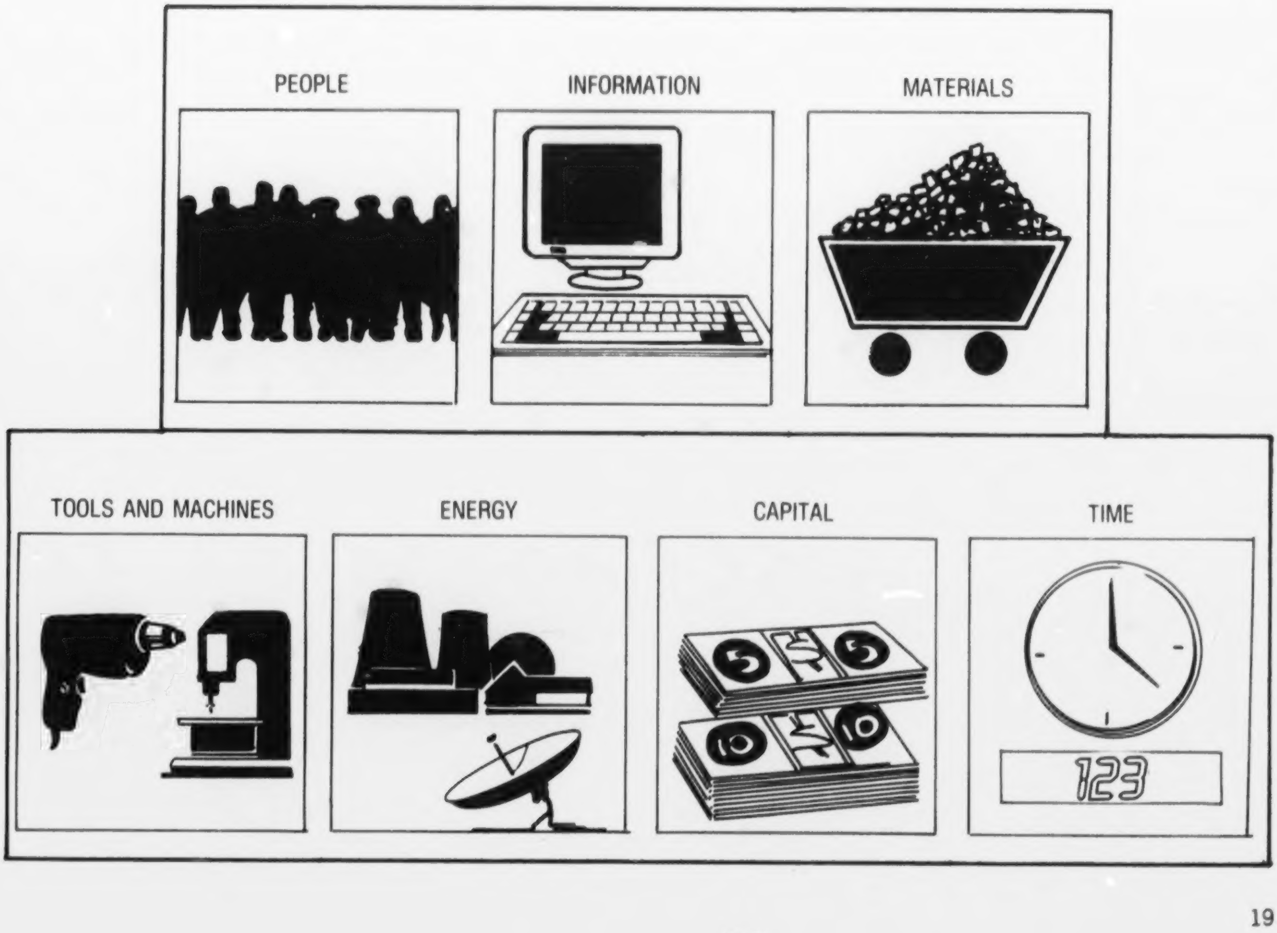
MODULE T-2
WHAT RESOURCES ARE NEEDED FOR TECHNOLOGY

PREREQUISITES:

Module T-1

SUGGESTED TEACHING TIME:

3-4 Weeks
15-20 Forty-minute Periods


PEOPLE
INFORMATION
MATERIALS
TOOLS AND MACHINES
ENERGY
CAPITAL
TIME
123

MODULE T-2
WHAT RESOURCES ARE NEEDED FOR TECHNOLOGY

OVERVIEW OF MODULE

GOAL

In this module students will explore and use the seven basic resources which are necessary for technology.

DESCRIPTION

Technology is resource intensive, and generic resources will be shown to be present in all technological endeavors within biologically related, information/communication, and physical systems. Seven categories of resources are involved: people, information, materials, tools and machines, energy, capital, and time. The cultural context will be shown to have bearing on the degree to which technological development is supported or discouraged.

This module will introduce students to examples of resources within each of the seven categories.

ENABLING VOCABULARY

Definitions will be found in the Technology Education glossary of terms.

CAPITAL

CULTURE

ENERGY

GLOBAL DISTRIBUTION OF RESOURCES

INFORMATION

LIFE CYCLE

MATERIALS

PEOPLE

RESOURCES - FINITE

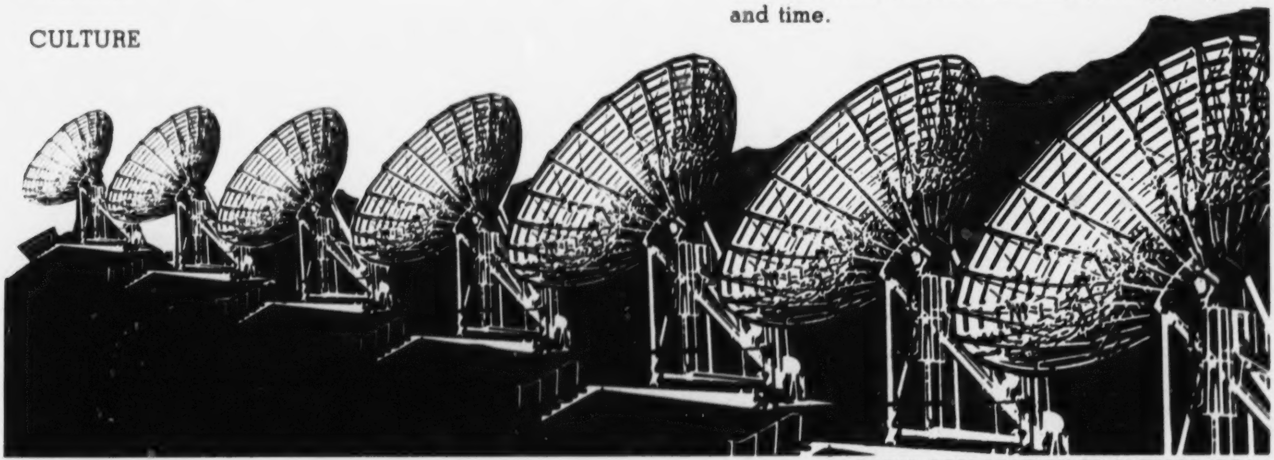
RESOURCES - NONRENEWABLE

TIME

TOOLS AND MACHINES

MAJOR CONCEPTS TO BE DEVELOPED

T-2 A. Every technological development is dependent upon the utilization of seven resources: people, information, materials, tools and machines, energy, capital, and time.



RADIO CORPORATION OF AMERICA (RCA)

T-2 B. Solutions to technological problems require the development of skills in using all seven resources.

T-2 C. The development and use of technology is influenced by the culture of a society and by the resources available to that society.

T-2 D. Global resources are finite, requiring discretion in their use, and, ultimately, the identification of alternatives.

PERFORMANCE OBJECTIVES/ SUPPORTING COMPETENCIES*

1. Given the seven resources of technology, the student will investigate the different forms of each resource category. The student will then select one or more of these resources and demonstrate how it can be used.

   In order to do this, the student must be able to:
   a. Recognize and list examples under each resource.
   b. Organize and record data.
   c. Use materials, tools, instruments, equipment, and procedures safely in a laboratory.

2. Given appropriate instruction and specifically limited access to the seven technological resources, the student will utilize these seven resources (but only to the specified limits), to produce a product, transport an object, grow living material, communicate an idea, or implement a process, and will describe how full access to resources would have led to improved results.

   In order to do this, the student must be able to:
   a. Demonstrate how resources are utilized (processed or converted).
   b. Identify how technological development is dependent on the seven resources.
   c. Use materials, tools, instruments, equipment and procedures safely in a laboratory.

3. Given examples of two nations with differing cultural conditions and differing amounts of nonrenewable resources, the student will identify technological alternatives which would be appropriate for each nation to satisfy a given human need.

   In order to do this, the student must be able to:
   a. Distinguish between renewable and nonrenewable finite resources.
   b. Recognize appropriate technological alternatives to specific resources.
   c. Carry out research.

SUGGESTED INSTRUCTIONAL STRATEGIES

Instructional strategies may be homework assignments, classroom activities or laboratory work. Those strategies to be implemented in the laboratory should be developed according to the Technology Learning Activity (TLA) format. In all cases, a variety of approaches for instruction and evaluation should be used to address the needs of individual students.

1. Perform experiments to explore properties of materials (hardness, brittleness, viscosity, malleability, ductility, elasticity, electrical properties, moisture tests on soil, etc.)

2. Organize and perform activities which involve processing of the resources of energy, information, or materials.

3. Establish a simulated barter/reward system in class with specific "capital" (*e.g.*, tokens, chips, coupons, cards).*

4. Carry out a task limiting the class to only those resources available in a developing nation.*

5. Develop a logo which communicates the seven resources for technology.

6. Construct a wind chime which illustrates the sound produced by certain materials.

7. Construct a hanging mobile which represents the seven resources for technology.

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*All student performance objectives have been written without specific evaluative criteria. It is expected that teachers will specify minimum performance levels consistent with the ability levels of their groups.

8. Develop a display which illustrates how some countries (like the United States) have a small percentage of the world's population, yet consume a large percentage of the world's energy resources.

9. Silk screen a "resources for technology" logo onto a T-shirt.

10. Use the combined resources of your class to accomplish a difficult task.*

11. Produce a device using synthetic or composite materials.

12. Manufacture glass from chemicals (See The Technology Teacher, January 1985, pages 9-12).

13. Have students list the specific resources necessary in a process such as printing a newspaper, running a TV or radio station, running a dairy farm, manufacturing skateboards, or operating a research laboratory, etc.

14. In the beginning of the semester allow each student a paper credit sum of $1000 to "purchase" any stock or bond which is listed in the stock market report of the local newpaper. A daily entry on a graph is to be made and at a predetermined time it must be "sold" with the resulting calculation of loss or gain. The highest achiever gets a prize.

15. A corporation can be formed to mass-produce a salable object designed by the class and manufactured on an assembly line using lab facilities and incorporating as many robots as possible. Time studies and wage rates can be established with each student "earning" according to time spent in each operation - (even the "bookkeeper").*

16. Let students make a box or small project, under careful supervision, out of sheetmetal, wood, ceramics or plastics of specified size but without any instruction as to techniques or design from the instructor (provide safety instruction.) After sufficient time and labor, stop the process, analyze the results by class critique and then give instructions on use of planning, measuring skills, tools, machines, etc., and reinforce proper safety procedures. Let students design and make their project and again critique the results with comparison of "before and after." Calculate costs of materials.

17. Have students design a program for the laboratory computer to design their own monograms. Run the program and make necessary corrections; then print out the results. Save the results on disk or tape to be used later for T-shirt designs.

18. Have students select a process from strategy 13 and detail, by drawing, or other modeling technique, the energy used by that process and define its source. Then describe how each operation could or could not be done if that energy form were no longer available.

19. Have the student create an energy conversion device by building a thermocouple, a voltaic cell, a solar collector, a magneto, a generator, etc. Measure its output quantity and calculate the sale price of that energy form over a given period of time.

20. Investigate the resource, people, by cutting out a picture of "people on the job." Research the job requirements, pay, opportunity for advancement, etc. Make a bulletin board of the results.

21. Pick a resource category and investigate and discuss one item in that category (*e.g.*, tools, materials, time).

22. Investigate resources that are available within a 50 mile radius of the community in which students live. List the local products made from these resources.

23. Have students generate ideas on how they would invest profits from an imaginary manufacturing company.

24. Run a mass-production project with all the jigs and fixtures made by the teacher. Cover the following topics: seven resources used, flow charts, job applications, interviews for the jobs, inventory sheets, advertisements, logos, on-the-job training.

25. Conduct a survey of local businesses to see what kinds of resources they use in the operation of their enterprise. Cover all seven resource areas.

26. Determine resources and develop an enterprise. For example: raise animals, grow crops, or mass produce products for sale.*

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*These strategies promote leadership qualities such as communication skills, decision-making abilities, problem-solving abilities, management skills, the ability to motivate others and to understand human relationships.

SUGGESTIONS FOR MODIFYING INSTRUCTIONAL TECHNIQUES OR MATERIALS

Many of the vocabulary terms in the module involve abstract concepts that can be difficult for some young learners. The use of examples and practical applications may be helpful for processes and techniques of cutting, fastening, or information storage. Pictorial definitions and categorizing may also contribute to understanding of skills. Specific items such as wood, metals, and plastics may be represented by pictures and presented as materials. Students may benefit from classifying skill and materials items using teacher and student examples. Activities can include wall displays introducing pictorial representations of the seven resources of technology.

Teacher reinforcement of terminology is important for retention. As a student is working, identify the wood being used as a resource or material, identify the student as the human resource, identify the source of power as energy. Allowing students to repeat terms or phrases and ask questions at such times will increase the impact of the interaction.

The classification of tools as simple machines may require many more examples of the tools. The use of the film, Simple Machines, Using Mechanical Advantage or other audiovisual materials with the opportunity to actually perform some of the experiments contained therein will add to practical experiences for students.

MODULE T-3
HOW PEOPLE USE TECHNOLOGY TO SOLVE PROBLEMS

PREREQUISITES:

Modules T-1 — T-2

SUGGESTED TEACHING TIME:

3-4 Weeks

15-20 Forty-minute Periods

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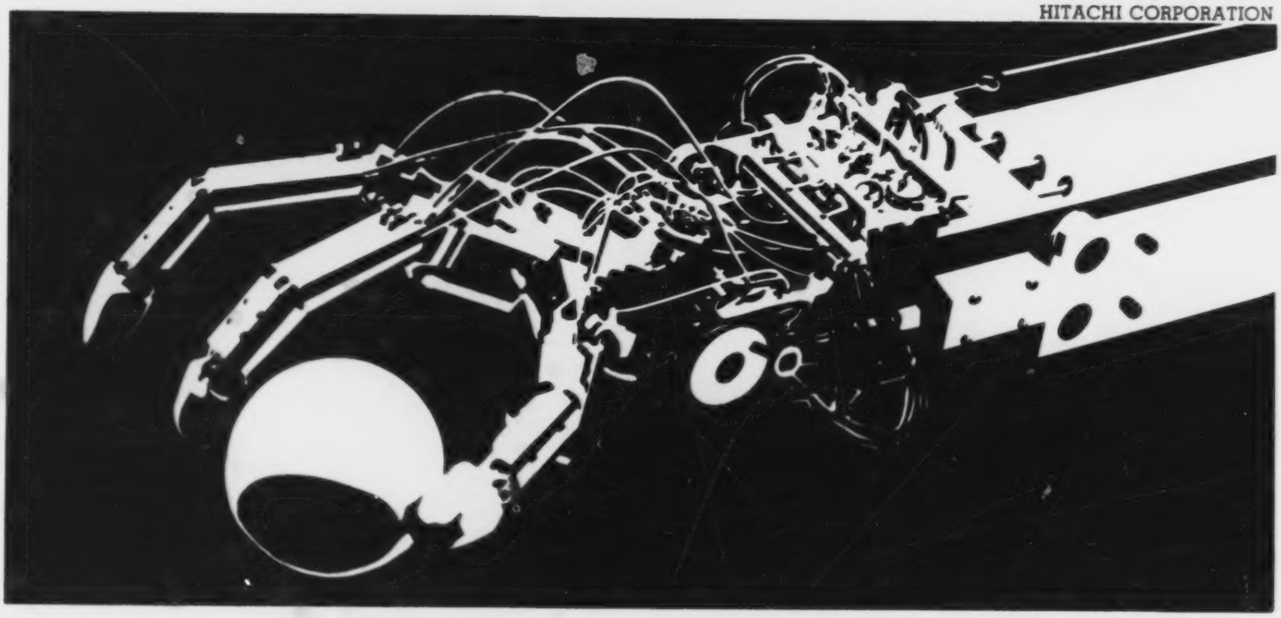

MODULE T-3
HOW PEOPLE USE TECHNOLOGY TO SOLVE PROBLEMS

OVERVIEW OF MODULE

GOAL

In this module, students will explore and experience how people can solve technological problems by using a formalized problem solving "system."

DESCRIPTION

In this module, students will be presented with technological problems and will explore solutions to them. The students will apply a specific problem solving method. The problem and its specifications and limitations will be defined for the student. Elements of design, ergonomics, and engineering concepts, such as optimization and tradeoffs, will be addressed.

The psychomotor skills, specific processes, and safe and proper procedures introduced in the previous modules will be reinforced and/or further developed.

The problem-solving experience in this module will be used as an introduction to the major concepts in the subsequent module, T-4, "What Must Be Known About Systems and Subsystems." It would be useful for teachers to refer to Module 1 of the Home and Careers Skills Syllabus, "The Process," in order to coordinate terminology and techniques.

ENABLING VOCABULARY

Definitions will be found in the Technology Education glossary of terms.

AESTHETICS

BRAINSTORMING

CONSTRAINTS

CRITERION

DATA

DESIGN

ENGINEERING

ERGONOMICS

EVALUATE

HYPOTHESIS

MODELING

OPTIMIZATION

PROBLEM

PROTOTYPE

RESEARCH

SCIENTIFIC PRINCIPLES

TRADEOFF

TRIAL AND ERROR

VALUES

MAJOR CONCEPTS TO BE DEVELOPED

T-3 A. There are formalized methods (systems) used to solve technological problems or make technological decisions.

T-3 B. The problem-solving process includes design (planning) and implementation.

T-3 C. An important part of the problem-solving process involves the generation of alternatives and the search for the optimal solution.

T-3 D. Optimization of a solution normally requires trade-offs, in order to best meet the specified design criteria

T-3 E. Modeling techniques (see definitions - glossary) are useful problem-solving aids.

T-3 F. Some problems cannot be solved by technology because of constraints imposed by scientific principles, resource limitations, and/or constraints resulting from people's values and attitudes.

PERFORMANCE OBJECTIVES/ SUPPORTING COMPETENCIES*

1. The student will design and implement the optimal solution to a given technological problem through laboratory-based activities and using a formalized problem-solving method. (See Instructional Strategy #1). The problem will involve biologically-related technology, information/communication technology and/or physical technology and the solution will meet the stated problem criteria and limitations.**

   In order to do this, the student must be able to:
   a. List problem-solving steps.
   b. Employ laboratory-based activities such as: use of living material, construction of devices, use of working models, charts, graphs, technical drawings, sketches and illustrations, mathematical equations, computer simulations, etc.
   c. Collect, organize and evaluate data.
   d. Use materials, tools, instruments, equipment and procedures safely in a laboratory.

2. Given a technological problem in one or more of the three aspects of technology that presently defies solution, students will identify constraints which prevent the problem from being solved. Students will then classify the constraints as those imposed by resource limitations, values and/or attitudes of people, and scientific principles.

   In order to do this, the student must be able to:
   a. Recognize how technology is limited by scientific principles (*e.g.*, perpetual motion cannot be achieved; work efficiency of more than 100% is impossible).
   b. Identify resources.
   c. Describe limitations imposed by the seven technological resources (*e.g.*, economic constraints prevent use of the space shuttle for everyday tranportation; material constraints prevent the use of wood as building materials in arid climates).

SUGGESTED INSTRUCTIONAL STRATEGIES

Instructional strategies may be homework assignments, classroom activities or laboratory work. Those strategies to be implemented in the laboratory should be developed according to the Technology Learning Activity (TLA) format. In all cases, a variety of approaches for instruction and evaluation should be used to address the needs of individual students.

1. Use a problem-solving model to apply the formal problem-solving process to the solution to a given problem.*

   STEPS IN THE PROBLEM-SOLVING PROCESS
   1. Identify and define the problem
   2. Set goals and identify criteria
   3. Generate alternatives and consider limitations
   4. Select the optimal solution
   5. Implement the solution
   6. Evaluate the results and make modifications, if necessary

2. Employ techniques for generating alternative solutions, such as: group brainstorming, role playing, trial and error, simulations, insight, research, etc.*

3. Design and construct a mechanical toy. Use kit materials, raw materials, or preprocessed materials; include an energy source.*

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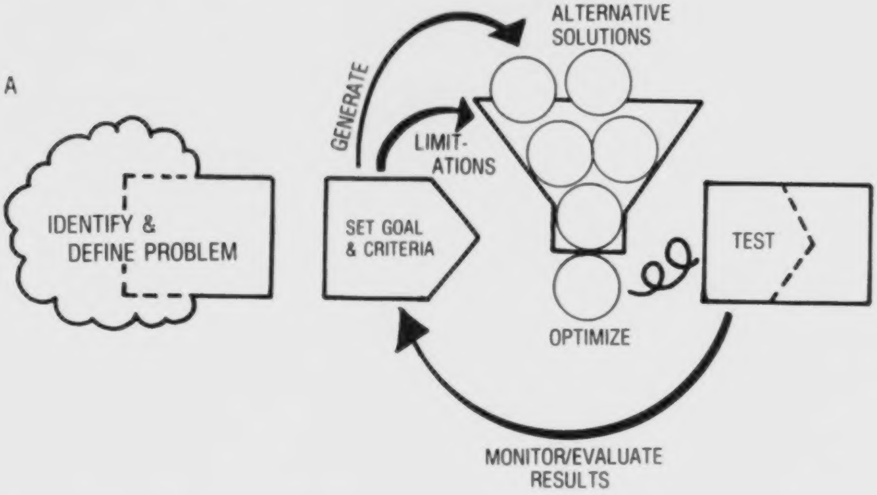
*All student performance objectives have been written without specific evaluative criteria. It is expected that teachers will specify minimum performance levels consistent with the ability levels of their groups.

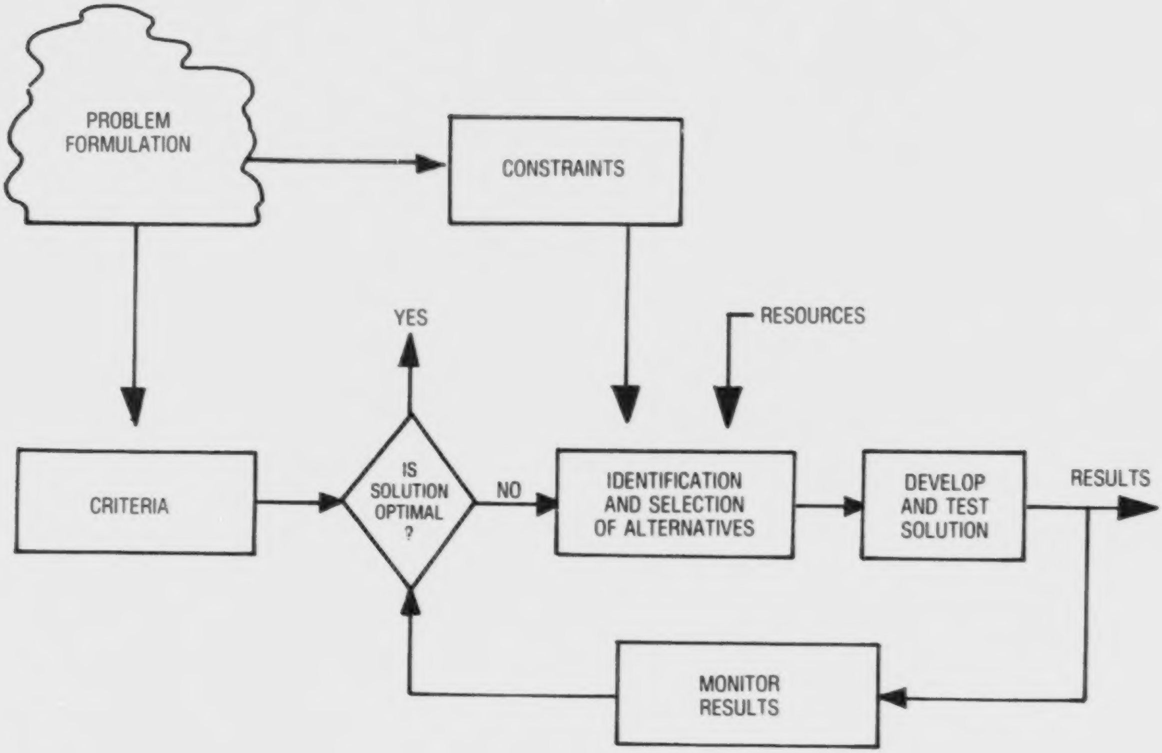
**Throughout this curriculum, "aspects of technology" shall be intended to mean biologically related information/communication and physical technologies.

PROBLEM SOLVING MODELS

MODEL A


ALTERNATIVE SOLUTIONS
GENERATE
LIMIT-ATIONS
IDENTIFY & DEFINE PROBLEM
SET GOAL & CRITERIA
TEST
OPTIMIZE
MONITOR/EVALUATE RESULTS

MODEL B


PROBLEM FORMULATION
CONSTRAINTS
RESOURCES
YES
CRITERIA
IS SOLUTION OPTIMAL ?
NO
IDENTIFICATION AND SELECTION OF ALTERNATIVES
DEVELOP AND TEST SOLUTION
RESULTS
MONITOR RESULTS

4. Design, construct, and field-test a kite or model aircraft.*

5. Follow guidelines of competition sponsored by the Junior Engineering Technical Society (JETS).*

6. Follow guidelines of compteition sponsored by Odyssey of the Mind.*

7. Follow guidelines of competition sponsored by the American Society of Mechanical Engineers, United Engineering Center, 345 East 47th Street, New York City, NY 10017.*

8. Follow guidelines of competition sponsored by a local Model Aircraft Association.*

9. Follow guidelines of competiton sponsored by the International Technology Education Association (formally the American Industrial Arts Association, 1914 Association Drive, Reston, Virginia 22091.)*

10. Critique the school or other building regarding accessibility. Select solutions for inaccessible areas and propose ways to implement solutions.*

11. Visit a local senior citizen center. After talking with the residents and determining their needs, design and construct a device to minimize a particular disability or mobility problem they are having. (*e.g.*, page turner, mobility aid, communication board, organizer, letter-writing guide).*

12. Perpetual Motion Devices: Class activity may involve investigating previous attempts at building perpetual motion devices and analyzing why they cannot work. One device, sometimes suggested by students, is a motor which drives a generator, which then powers the motor. Another is a transformer, which steps voltage up above the input voltage. Electric current, however, is correspondingly reduced, so the output power is never more than the input power.*

    Students may also be given the opportunity to design a perpetual motion machine. Students might build a device like a spinning top, and try to OPTIMIZE the spin time by making the device as friction free as possible. A competition could be staged among student groups.

13. Give students some specific resource limitations and ask them to construct a device to serve a specified purpose while adhering to those limitations.*

14. Present a problem to solve. Issue a bag of parts, and play money. Let students operate a store to sell additional materials to solve the problem. Example of a problem might be to build the fastest model boat, car, or rocket.

15. Design a speech, present a demonstration, or structure a debate describing how people use Technology to solve problems.*

16. Report or demonstrate how technology has solved problems relating to making life safer or more efficient.*

SUGGESTIONS FOR MODIFYING INSTRUCTIONAL TECHNIQUES OR MATERIALS

The problem-solving module is seen as one of the most important segments of the Technology Education program. Problem-solving requires generalization of information and application and adaptation of what is learned in various situations. Many students, including those with handicapping conditions, will progress with specified parameters, limited variables, concrete choices, and a great deal of guidance. Progress in problem-solving ability will depend, in part, on prior experience, specific ability, and self-concept.

In any case, the first problem-solving experience may be a simple choice between two concrete options. Examples include: selection of material for an activity in module T-1, decisions pertaining to possible tools, or devices to produce in module T-2, or selection of shapes of materials used in fastening processes in module T-3. Students might progress to making two decisions from each of two sets of options, then three decisions, and so on, with widening sets of options. Through transition, students should be able to attempt more open-ended problems.

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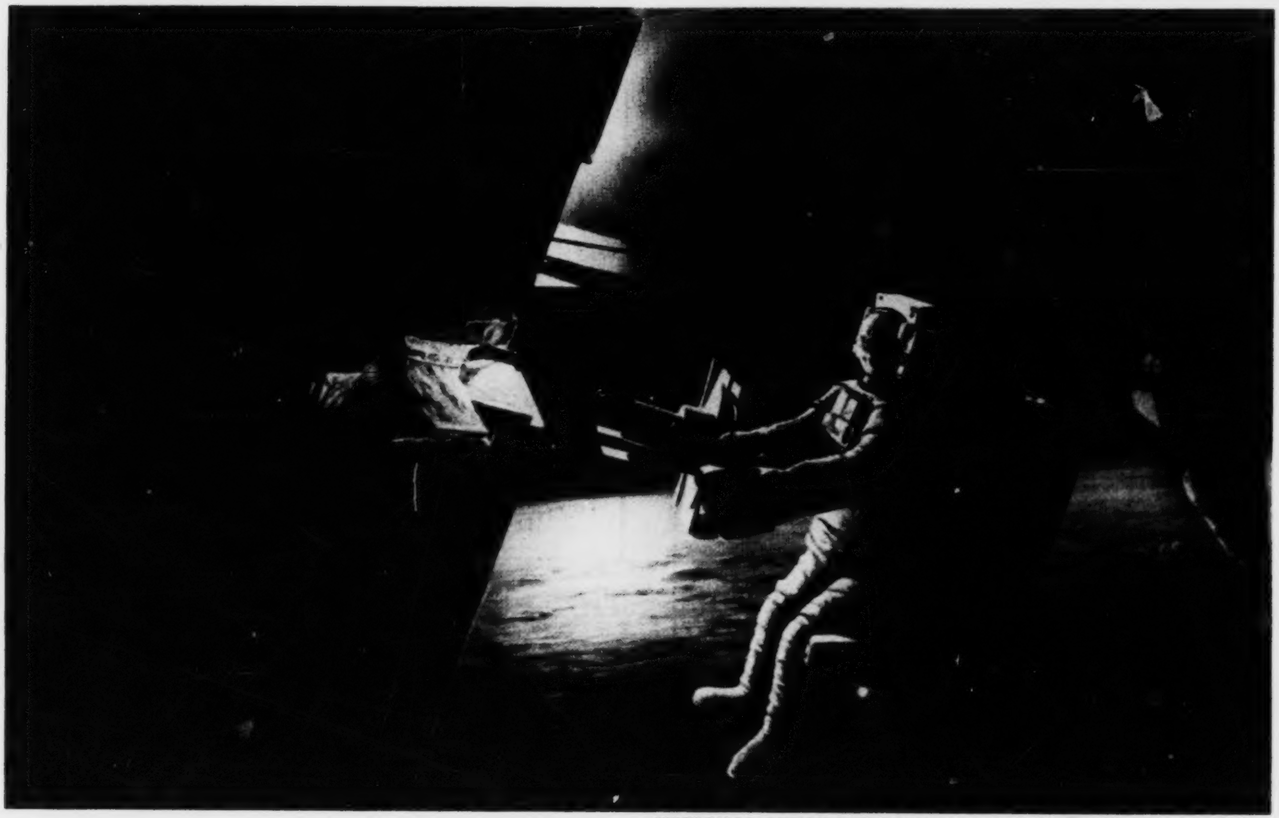
*These strategies promote leadership qualities such as communication skills, decision-making abilities, problem-solving abilities, management skills, the ability to motivate others and to understand human relationships.

Many students with learning problems will require considerable support and encouragement. A poor self-image can be uplifted and changed through equal opportunity for success. Creativity is a major component of problem solving. Learning through creative problem solving will provide the opportunity to tap each student's strengths and talents. Resource room teachers, guidance counselors, and special educators may be a source of helpful information on each child's management needs, potential, and areas of interest and experience. Discussions with others often provide alternative approaches that enable student success.



NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA)

MODULE T-4
SYSTEMS AND SUBSYSTEMS IN TECHNOLOGY

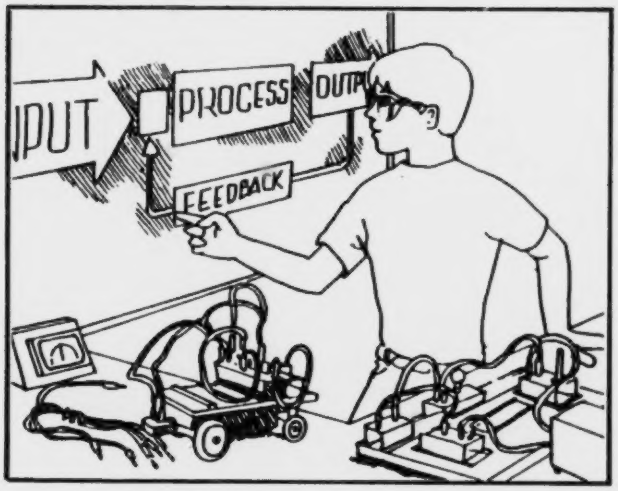
PREREQUISITES:

Modules T-1 — T-3

SUGGESTED TEACHING TIME:

4-5 Weeks

20-25 Forty-minute Periods


IPUT
PROCESS
OUTP
FEEDBACK

MODULE T-4
SYSTEMS AND SUBSYSTEMS IN TECHNOLOGY

OVERVIEW OF MODULE

GOAL

This module is designed to provide students with an introduction to the structure, function, components and control of technological systems. Through a study of generic systems concepts, students will gain an understanding of the similarities that exist among physical, information/communication, and biologically related technological systems.

DESCRIPTION

We are surrounded by examples of technological systems which are in place to help people cope more easily with their environment. Modern systems are frequently controlled automatically and can adjust themselves to changing conditions. Older systems, on the other hand, are apt to require some form of manual control. In older cars speed is regulated manually by the driver's foot pressure on the gas pedal; in new cars, optional cruise controls are available which automatically maintain the speed at a preset level. Temperatures in homes and apartments were once controlled by adding more wood to a stove, by opening windows, or by turning on a fan. Today, modern heating and air-conditioning systems automatically keep room temperature at the desired level.

Not long ago, most wristwatches were mechanical devices which required periodic winding and adjustment. Modern digital watches use electronic methods to control accuracy and can run for long periods of time on a single, small battery.

With the invention of the microprocessor, many different combinations of conditions can now be taken into consideration within a system and the system responds with the best possible compromise. In modern automobiles, for example, fuel supply is adjusted automatically in response to changes in engine speed, humidity, temperature, and other factors. Living organisms are also systems; the human body can be viewed as an example of a biological system. Body temperature, moisture content, balance, and other functions are controlled by internal, biological processes.

Systems concepts studied in this module will engender an understanding of simple systems theory and thus provide students with a powerful tool with which to analyze and interpret new systems as they are encountered. Students will study concepts generic to all technological systems and will construct and operate systems to learn how they function.

ENABLING VOCABULARY

Definitions will be found in the Technology Education glossary of terms.

ADJUSTMENT

AUTOMATIC CONTROL

CLOSED-LOOP SYSTEM

COMMAND INPUT

COMPARISON

CONFLUENCE OF SYSTEMS

CONTROL

FEEDBACK

INPUT

MONITORING

OPEN-LOOP SYSTEM

PRE-PROGRAMMING

PROCESS

SUBSYSTEM

SYSTEM

TECHNOLOGICAL SYSTEM

MAJOR CONCEPTS TO BE DEVELOPED

T-4 A. New technologies often evolve as a result of combining existing technologies (confluence of systems).

T-4 B. A technological system is one through which a technological process combines resources to provide an output in response to a command input.

T-4 C. People design systems to satisfy their needs and wants.

T-4 D. The basic systems model can be used as a tool to analyze systems in all aspects of technology.

T-4 E. When two or more systems are combined to form a new system, the original systems become subsystems of the new system.

T-4 F. People combine subsystems in order to produce more powerful systems.

T-4 G. Open-loop systems are unable to adjust for changing conditions.

T-4 H. The addition of feedback to open-loop systems provides an increased measure of control to the resulting closed-loop system.

PERFORMANCE OBJECTIVES/ SUPPORTING COMPETENCIES*

1. Given examples of common technological systems in each of the three aspects of technology, the student will model a system in biologically related, information/communication, and physical technology using the basic systems block diagram.**

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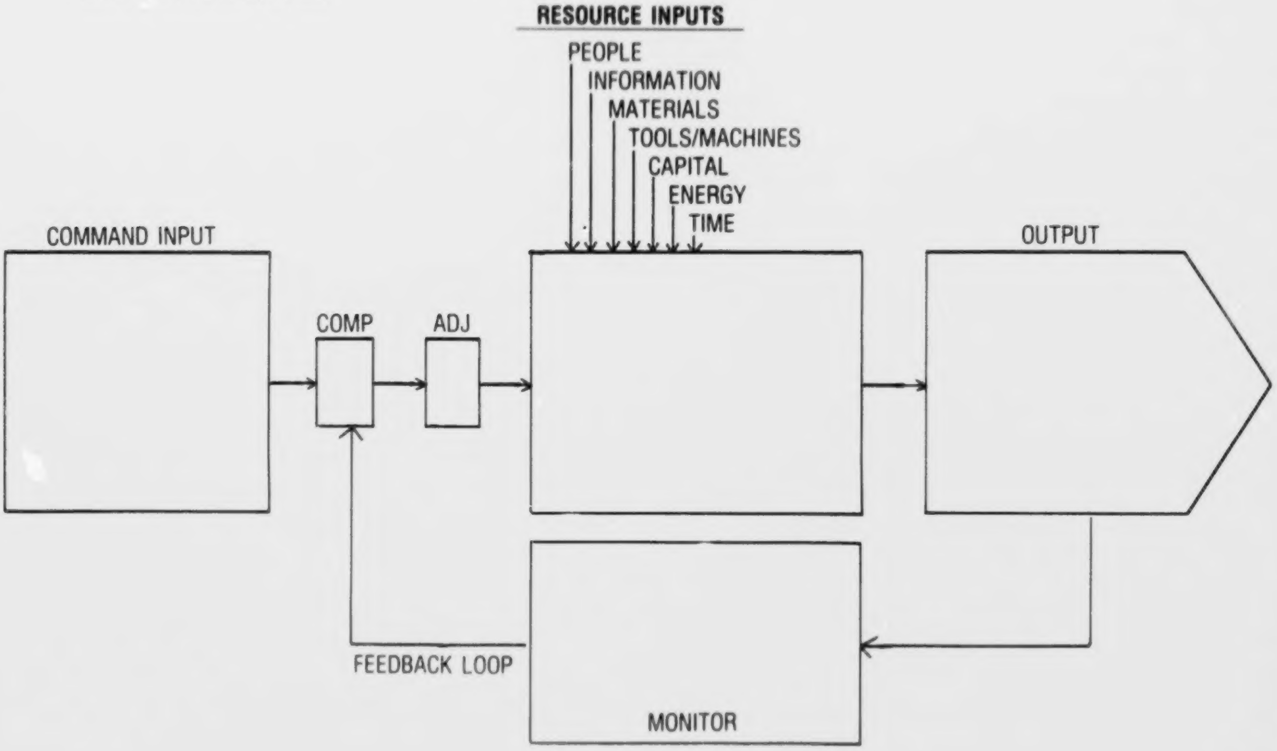
*All student performance objectives have been written without specific evaluative criteria. It is expected that teachers will specify minimum performance levels consistent with the ability levels of their groups.

**Throughout this curriculum, "aspects of technology" shall be intended to mean biologically related, information/communication and physical technologies.



In order to do this, the student must be able to:
a. Identify the components of a system (input, process, output, monitor, comparison).
b. Draw a labeled systems model in block diagram form indicating how the system components are linked.
c. Describe the monitoring and feedback portion of the systems model.

2. Given appropriate materials, the student will apply the technological systems model to the safe assembly or construction and operation of a system which encompasses biologically related, information/communication, and/or physical technology.

In order to do this, the student must be able to:
a. Identify the components of a system (input, process, output, monitor, comparison).
b. Test, evaluate, and adjust/modify a system.
c. Use materials, tools, instruments, equipment, and procedures safely in a laboratory.

3. Given a need, specified desired results and an operable open-loop system to satisfy the need, the student will add feedback to close the loop and then safely operate the system in order to bring actual results closer to desired results.

In order to do this, the student must be able to:
a. Distinguish between open-loop and closed-loop systems.
b. Monitor actual results and compare to desired results.
c. Adjust system performance.
d. Use materials, tools, instruments, equipment, and procedures safely in a laboratory.

4. Given an example of a modern, complex technological system from each of the three aspects of technology. The student will identify the subsystems and explain how they have been combined to generate the new system resulting in improved or additional human capabilities.

In order to do this, the student must be able to:
a. Differentiate between systems and subsystems.
b. Analyze and identify subsystems within the system.
c. Utilize systems diagrams.

SUGGESTED INSTRUCTIONAL STRATEGIES

Instructional strategies may be homework assignments, classroom activites, or laboratory work. Those strategies to be implemented in the laboratory should be developed according to the Technology Learning Activity (TLA) format. In all cases, a variety of approaches for instruction and evaluation should be used to address the needs of individual students.

1. Mass-Production of "Tantalizer": Students will manufacture a product through mass-production and assembly-line techniques. The product suggested is a "tantalizer" game which itself can be used to teach the concept of feedback. Discuss with the class the structure of a mass-production manufacturing system. Relate differences between hand-made crafts and mass-produced products. Discuss quality control, feedback, and system adjustment as they relate to an assembly line system. Show how a graph can be developed to compare production levels over a period of time. Such a time study should reinforce the graphing concepts learned in mathematics classes.

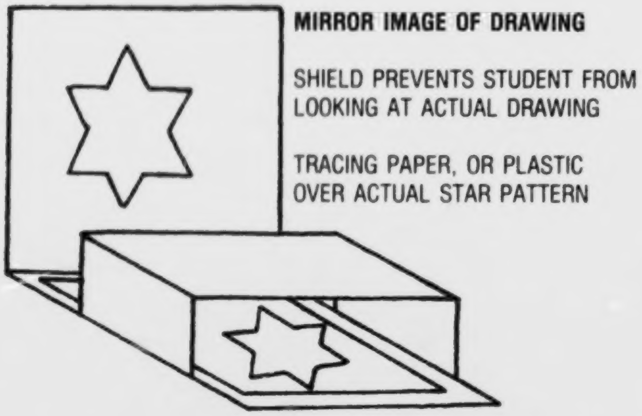
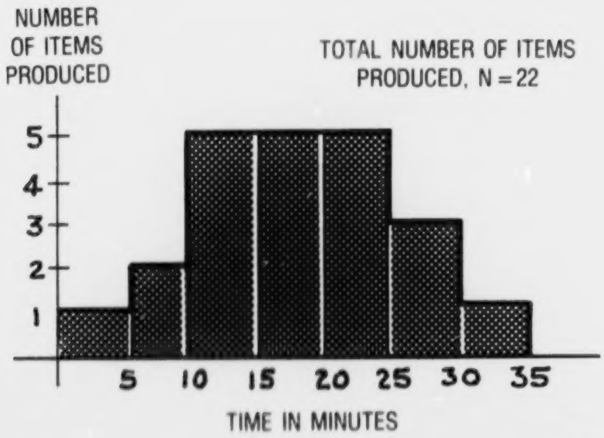

MIRROR IMAGE OF DRAWING
SHIELD PREVENTS STUDENT FROM LOOKING AT ACTUAL DRAWING
TRACING PAPER, OR PLASTIC OVER ACTUAL STAR PATTERN

FIGURE ONE: APPARATUS FOR FEEDBACK EXPERIMENT

The "tantalizer" is a clever game which involves the use of a mirror to follow a star-shaped outline. The student is not permitted to look at the actual star, only at its image in a mirror. He or she is asked to trace the pattern while looking at the image in the mirror. The feedback expected is not received, and it takes time for the student to become accustomed to the reversed feedback that is being provided.

The histogram below illustrates how a graph may be used to show production levels over a given period of time.*



2. Demonstrate a photoelectric light controller which can be used to automatically turn a room light on when it gets dark outside. The advantage of using a device such as this to illustrate systems concepts is that students can be shown a feedback system that is automatic. Many modern industrial processes use automatic feedback controls. Examples include: numerically controlled machines, robots, computer-aided design systems, and temperature sensors connected to a microprocessor controller to maintain a constant temperature.

3. Construct a rocket from a kit and analyze it in systems terms. This activity provides an excellent opportunity for students to see how a major system (the transportation system) can be viewed in terms of its subsystems (a rocket system being one such subsystem). It will also provide an opportunity to consider subsystems of a subsystem (ignition, recovery, guidance, etc.). The activity, furthermore, will provide an excellent lead-in to the next module, How Technology Affects People and the Environment.*

4. Develop a student-run mass-production line. Feedback is usually visual (or tactile), measured by a machine operator who adjusts the process according to what he or she sees (or feels).*

5. Develop a system to print photographs or offset copy. The quality of the print is measured by the student. The visual feedback is used to control the exposure time or impression (process).*

6. Prepare a TV commercial or printed advertisement that is intended to change attitudes, sell a product, or evoke laughter. The degree to which the desired result is accomplished is measured by the student. This feedback is used to compare desired and actual results, and the advertisement (process) is modified (adjustment) to achieve desired results.*

7. Discuss household items viewed in systems terms. A toilet and tank float mechanism illustrate how feedback works. When the water level in the tank is at the proper level, the float (which controls the flow of water) shuts off the flow. Home heating systems (and ovens) are also good examples of closed-loop systems. In these cases, automatic feedback is present. The temperature of the house (or the oven) is maintained at a constant temperature due to feedback from a thermostat which acts as a monitor, sensing temperature, and also as a controller, turning on and off the furnace (or oven).

8. The feedback concept is simply explained by asking the student to draw a line exactly centered between two parallel lines. Visual feedback is provided by the student's eyes, and the brain causes him/her to adjust the position of the line being drawn.

9. Construct or disassemble a pump with valves. Compare to a heart.

10. Visit a farm; milk a cow; relate to automatic milking machines/systems.

11. High Technology - Confluence of systems: This laboratory activity may involve the use of high technology systems such as robotic arms, computer-aided design, electronic devices using printed circuit boards, telephones, video-cassette recorders, personal computers, autofocus cameras, etc. An inexpensive robotic arm, such as the toy that is manufactured by

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*These strategies promote leadership qualities such as communication skills, decision-making abilities, problem-solving abilities, management skill, the ability to motivate others and to understand human relationships.

Armatron and sold by Radio Shack, could be used as a stage on a production line to transfer a particular part from one operation to another. The axes of movement and the flexibiltiy of the device could be demonstrated in this manner at low cost. Other high technology toys that may be useful for demonstration of systems concepts are "Big Trak" and radio-controlled planes and cars.

An important point that should be made to students is that the powerful high technologies, which today are responsible for driving our society, have been developed as a result of combining previous technologies (the confluence of systems) and using knowledge gained in the past. When technologies combine, they form new, more powerful technologies. Some examples are: automated supermarket laser scanners (used with Universal Product Codes), digital computers, and modern communications devices using voice recognition technology.

12. Introduce such topics as: entrepreneurship, how small businesses get started, and time study and/or time management. Role play job interviews, discuss how appearance communicates information about an individual. Discuss peer supervision, personnel simulation, profit motives, scheduling, delegating responsibilities, etc.

13. Active role models can make contributions as presenters, consultants, and mentors when a TLA involves individual or group problem solving over an extended period of time. Students can be encouraged to seek the advice of a role model. Instructors may wish to recruit male and female college engineering students, for example, as group "mentors" who might greatly enhance the success of applied technological activites.

14. Use activities from SPACES, Spacial Encounters and Equals (Available from Project VOICE/MOVE, Albany-Schoharie-Schenectady County BOCES, 1015 Watervliet-Shaker Road, Albany, NY 12205). These activities can help students overcome educational and experiential difficulties in math/science areas.

SUGGESTIONS FOR MODIFYING INSTRUCTIONAL TECHNIQUES OR MATERIALS

This module involves considerable abstract information and requires students to demonstrate their ability to innovate and apply a store of factual knowledge. The categorization of systems and subsystems will facilitate a general understanding. Students should be able to group examples according to the categories of physical technology, biologically related technology, and information/communication technology if care is first taken to define these categories in concrete terms.

Teachers might also present examples of systems and have them manipulate one of the processes noting the effects on the outputs of the sytem. It may be appropriate to understand the specific actions and interrelationships within a system as well as to be able to label system elements using technical vocabulary terms.

If constructing and operating systems are required, plans and procedures can be provided on tape (audio or video) or in picture form to supplement the teacher's regular lesson presentation. Care must be taken to give all students concrete references to accommodate their developmental level and to provide varying levels of abstraction.

In a mass-production activity, as with most activities, teachers should be knowledgeable of student skill levels. Approaches may include directed instruction, comparison and contrast, planning and materials demonstration, observation, small group or team work, and alternative assessment. Effort should be made to review Individualized Education Programs (IEPs) for indications of individual strengths or weaknesses. This specific information, along with a supportive classroom environment, will provide the opportunity for all students to demonstrate skills to their best advantage.

The less complex classroom activities illustrating feedback will not pose difficulty for most students and may be useful as starter activities to build confidence. An additional teacher resource for illustrating systems and feedback is

Mr. Wizard's 401 Experiments in Science, by Don Herbert (1968), Book-Lab, Inc., 1449-37th Street, Brooklyn, NY 11218.

Students may experiment with different sizes and shapes of balloons and collars during exercises involving measurement (time, distance, recording, and graph construction). The use of the terminology to explain experiments will provide students with repetition to help acquire and retain new vocabulary terms.

MODULE T-5
HOW TECHNOLOGY AFFECTS PEOPLE AND THE ENVIRONMENT

PREREQUISITES:

Modules T-1 — T-4

SUGGESTED TEACHING TIME:

3-4 Weeks

15-20 Forty-minute Periods

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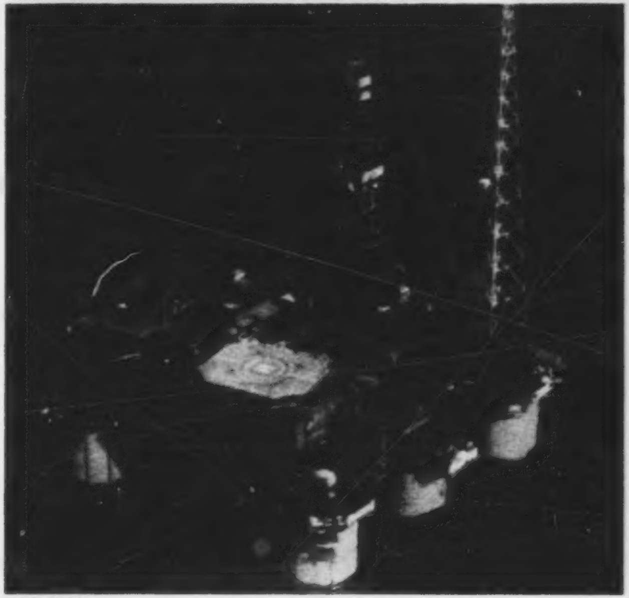

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MODULE T-5
HOW TECHNOLOGY AFFECTS PEOPLE AND THE ENVIRONMENT

OVERVIEW OF MODULE

GOAL

This module is designed to provide students with an understanding of the positive and negative impacts of technology. It should instill the perception that people must assume the responsibility for adapting technology to the environment and to the human user.

DESCRIPTION

Technology can provide us with many improvements, but can also create undesirable consequences. Whether technology has positive or negative effects will be determined by the way people use it. Nuclear energy can be used for peaceful purposes or for atomic bombs; television can be used to entertain as well as to spread propaganda; biologically related technology provides increased crop yields but also makes germ warfare possible.

Before a specific technology is employed, we must try to predict the consequences of its use. The outputs of the technological system can be desired, undesired, expected, or unexpected. Through proper planning, we can minimize undesired outputs. When we design chemical processing plants, we must consider how to dispose of waste products. If we dump the chemical waste into a nearby stream, we may very well kill the fish.

Technology should be adapted to the needs of the human user. Consider how buses can be designed to "kneel" to provide easier access for the physically disabled, or how car seats can be designed to provide maximum comfort and control. When we consider people's needs, we can design technological systems to meet them.

People have the capability to design and use technology so that it improves the quality of life. Biologically related technology, information/communication technology, and physical technology can all serve to benefit us if we employ them to meet the needs of human users and the environment.

ENABLING VOCABULARY

Definitions will be found in the Technology Education glossary of terms.

APPROPRIATE TECHNOLOGY

ECOSYSTEM

ENVIRONMENTAL IMPACTS OF TECHNOLOGY

HUMAN-MADE ENVIRONMENT

IMPACT

INTERDEPENDENCE

SOCIAL IMPACTS OF TECHNOLOGY

TECHNOLOGICAL ASSESSMENT

MAJOR CONCEPTS TO BE DEVELOPED

T-5 A. The output of a technological system can be desired, undesired, expected or unexpected.

T-5 B. Technological advancements produce many positive outcomes and solve many problems, but sometimes there are negative outcomes which create new problems like pollution, crowded highways, and an imbalance in our ecosystem.

T-5 C. Technology should be adapted to the human user (ergonomics).

T-5 D. Technology should be adapted to the environment (appropriate technology); the environment can be natural, human-made, or both.

T-5 E. Humans develop and control technology.

PERFORMANCE OBJECTIVES/ SUPPORTING COMPETENCIES*

1. Given an example of a technological system in each of three aspects of technology, the student will demonstrate through laboratory based activities in one or more of these technologies, outputs that are desired, undesired, expected, and unexpected.**

   In order to do this, the student must be able to:
   a. Identify and analyze outputs.
   b. Differentiate between and among desired, undesired, expected, and unexpected outputs.
   c. Apply system diagrams.
   d. Use materials, tools, instruments, equipment, and procedures safely in a laboratory.

2. Given examples of common technological systems from each of the three aspects of technology, the student will identify instances of the lack of fit between the technological system and the human user. The student will identify techniques for improving the match between the technology, the human user, and the human-made environment, and will demonstrate alternatives through modeling activities in order to improve the match in one or more of the given examples.

   In order to do this, the student must be able to:
   a. Understand ergonomics.
   b. Identify examples of how specific technologies are not designed to match the characteristics, capabilities, and limitations of human beings (*e.g.*, uncomfortable chairs, unsafe automobiles, lack of accessibility for the physically disabled, noise pollution).
   c. Use materials, tools, instruments, equipment and procedures safely in a laboratory to model a technological system.

3. Given examples of common technological systems from each of the three aspects of technology, the student will identify instances of the lack of fit between the technological system and the natural environment. The student will identify techniques for improving the match between the technology and the natural environment and will model alternatives through laboratory-based activities in order to improve the match.

   In order to do this, the student must be able to:
   a. Identify undesired outputs and effects.
   b. Research and analyze data in relation to environmental problems.
   c. Use materials, tools, instruments, equipment, and procedures safely in a laboratory to redesign a technological system.

SUGGESTED INSTRUCTIONAL STRATEGIES

Instructional strategies may be homework assignments, classroom activities or laboratory work. Those strategies to be implemented in the laboratory should be developed according to the Technology Learning Activity (TLA) format. In all cases, a variety of approaches for instruction and evaluation should be used to address the needs of individual students.

1. Ergonomics: Some technologies have been put in place which really do not "match" the human user. To help avoid this mismatch the field of ERGONOMICS has recently emerged. Ergonomics involves human engineering; that is, products and systems are developed which are comfortable for people to use and really fit their needs. A good example of ergonomic design is in the way automobile seats are constructed. The design is based upon maximizing human comfort while providing good driving position. The height of the seat, the materials used for its construction, and the position of the arm rests and back are all based upon the physical size and shape of most drivers as well as ease of movement and reach of arms and legs to the proper controls. Another example is a reconstructed van which accommodates a disability and allows an individual to drive using lifts and adaptations for operating the vehicle.

   The typewriter keyboard, developed by Christopher Sholes in 1866, on the other hand, is an example of a device not well matched to the human user. The keys were placed in awkward places, purposely, because early typewriter keys would jam if they were keyed too rapidly. Modern electronic typewriters respond much more quickly, but people have had to learn to adjust to the awkward key locations of the old typewriter keyboard. An interesting exercise might be to have students redesign the typewriter keyboard, placing the most frequently used letters on keys which are easily reached, and the least frequently used letters on keys involving the longest reaches and the weakest fingers.

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An alternative to the present keyboard is the Dvorak Keyboard. A layout of this keyboard ia available from Dr. Thomas Liao, Department of Technology and Society, Old Engineering Building, S.U.N.Y. at Stony Brook, Stony Brook, New York.

Some technologies have created a mismatch between humans and their environment by polluting the air and the water. Before new technologies are implemented, every possible attempt should be made to assess their environmental impacts and to weigh negative against positive outcomes. Technology appropriate to one location, one individual, or a particular society may not be well suited to another. A recommended activity might involve designing or redesigning some product to fit the needs of individuals with handicapping conditions. Drinking cups that don't easily spill, and bathtub or shower aids are possible candidates for redesign.

Some people who work at supermarket and check-out counters have now begun to develop a malady called the Carpal Tunnel Syndrome. This is related to the movement of the wrist as it passes a product with a Universal Product Code (UPC) through an optical scanner. It is defined as "a syndrome complex due to compression of the median nerve within the carpal tunnel, characterized by disturbances of sensations in the area of the skin supplied by the median nerve, pain on sharp flexion of the wrist, edema of the fingers, tense and shiny skin, and atrophy of the thenar muscles" (Blakiston's Pocket Medical Dictionary).

2. Biologically Related Technological Engineering: This activity would involve having students develop a model of a genetically engineererd human being (a six-million-dollar man). Would it be a good idea for scientists and technologists to try to engineer superhuman beings genetically? What are desired, undesired, expected and unexpected results? Perhaps have the students construct a model of a superior human being, using their imaginations.

3. The objective of this instructional strategy may be fulfilled either through laboratory activity or through a research project. If a research project is undertaken, it is suggested that individual students be assigned to report on a specific emerging technology like robotics, holography, or satellite communications. Rather than rely on the library as the sole source of information, students should be encouraged to call or write high technology companies and obtain information directly from technical personnel about the latest developments. Students should report back to class on the following aspects of the new development:

   - The current state of the technology
   - Impacts the technology has had on society (desired, undesired, expected, and unexpected)
   - Career opportunities the technology offers
   - An estimate of what the technology might look like ten years from now
   - Educational requirements necessary to work in the field
   - Entry-level salaries

   Charts and diagrams should accompany the oral presentation and a written report should be submitted. Copies should be provided each class member, if feasible, so that a notebook of information on emerging technology can be developed.*

4. Create a bulletin board pertaining to pictures of all kinds of technology.

5. Using newspapers and magazines, small groups of students may develop poster collages of pictures focusing on the utilization of technology in any of the following circumstances:

   a. Natural disasters
   b. Rescues
   c. Medical problems
   d. Food supplies

   Using these collages, the groups will describe through oral or written presentations, how technology is applied to match human and environmental needs.*

6. Given access to a variety of materials, the class will develop an audiovisual presentation of past and present technology used to solve problems. The students should point out how the new technology has solved a particular problem or how it has created new ones. Examples of the focus of the presentation: firefighting, medical facilities, entertainment, music reproduction, figuring family budgets through computer programs, optimizing animal feed mixes using a computer program.*

7. Given a scenario concerning current technological developments, students will role-play a simulation demonstrating conflicts between positive and negative outcomes; *e.g.*, the conflict raised by using robots which impinge upon people's jobs, supersonic jets, and rock music which creates noise.

8. Students may be asked to research a current technological development and present a panel discussion of the pros and cons of the issues being encountered, like new medical technologies that permit early identification of the sex and health of a fetus.*

9. Conduct a brainstorming session on "Needs of All Individuals." Through class discussion determine if each need is essential to the survival of all people. Compile a list of those needs common to all people.

10. Students will construct a hydroponic greenhouse as a means of describing how technology can provide solutions to growing plants and vegetables in an environment devoid of rich soil.

11. Design a habitat to support life in an unfriendly environment (*e.g.*, the moon, underwater, in space, etc.).

12. Students may make a solar still to reclaim clean water.

13. Student teams may be asked to investigate a global issue relating to technology (like nuclear power or supersonic transport) and argue both sides of the issue in a panel discussion in front of the class.

14. Using a computer with a simulation game, students may explore a technological issue to discover various choices and their ramifications.

15. Show a videotape of a TV show with some amounts of violence in order to discuss desired, undesired, expected, and unexpected results of television.

16. Run a production line and analyze the results. Desired and expected outputs are the products produced, desired and unexpected outputs may be such things as some students finding new interests, good public relations, high profits, etc. Undesired and expected outputs could be consumption of electricity, noise, clutter, etc. Undesired and unexpected outputs might include breaking a tool, products of poor quality, student or parent dissatisfaction, failure to make a profit, etc.

17. Students could model a recycling plant, electric car, smoke precipitator or waste disposal system.

18. Have students model a mock trial on how to respond to technological problems. A scenario could be similar to the NBC TV movie "Acceptable Risks," March 1986, where a local chemical plant exposed neighbors to hazardous chemical leaks. Students could then theorize how best to approach the aftermath or, more importantly, how to prevent such a problem.*

19. Have the students plan and carry out a trip to collect samples of soil, water, plants, etc., to test back in the lab.*

20. Participate in a youth organization community service project to improve the local environment.*

21. Participate in a youth organizaion trip or tour to area sites to view the effect of technology on people and the environment.*

22. Conduct public speaking and debating on how technology has affected people and the environment.*

23. Have students attend a leadership training camp or a nature center to develop an appreciation of a clean environment.*

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*These strategies promote leadership qualities such as communication skills, decision-making abilities, problem-solving abilities, management skills, the ability to motivate others and to understand human relationships.

SUGGESTIONS FOR MODIFYING INSTRUCTIONAL TECHNIQUES OR MATERIALS

Maslow's hierarchy of human needs is a well-known theory. Whatever psychological theory may be considered, practical classroom applications are useful. One approach to the discussion of shelter would be to find or produce photos of different types of shelters (houses, trailers, tents, campers, apartments, hotels, motels, and public shelters). Another approach would be to compare the adaptations of these shelters to seasonal changes. In relating this to the systems model, the desired results of keeping warm, or dry, or cool, would cause the person involved to make changes in other inputs such as sources of ventilation. Similarly, activities involving support and self-esteem would hold great potential for addressing other aspects of basic human needs.

For some students, concepts of evaporation and condensation which are presented in a solar still activity may be unclear. Supplement this project with one or more preparatory experiments. A simple one would be to place a wet plate in the sun; observe the change and identify it as evaporation. Conversely, put a few ice cubes in a glass; observe and identify condensation. A diagram of the water cycle could be used as a graphic illustration of the experiments.

It is highly probable that many young students will acquire a better understanding of a "molecule" by first developing a concrete awareness of water movement through the liquid-gas-liquid cycle. Another exercise pertaining to the unseen molecules within the air around us involves the use of the sense of smell. Place a small amount of perfume in a dish and have the students walk away from it. After a short while they should smell the perfume even though they are far from the dish. Have the student return and examine the dish. The perfume should be gone — evaporated and dispersed in the air just as the water had. The molecules of perfume are detectable by smell as they move throughout the air even though they are no longer visible.

The activity requiring the design of a perpetual-motion machine requires a certain degree of confidence and creativity. Students may be guided with pictures or films or early attempts to construct such machines and, from this information, develop better concepts of perpetual motion and understanding of reasons for wanting to develop such devices. Following these experiences, students may construct models or copy drawings as part of their hands-on experiences.

Students may modify a toy (like a spinning top), constructed in the first or third module of this course, in order to optimize its spin time. They may also use these tops to stage competitions and graph results. They might also make detailed observations of the tops that are most and least successful (by some stated criteria) and try to determine the aspects that have the greatest or most predictable effect.

The projects involving genetic engineering and independent research are not for every 7th grade student. If the class is grouped by interest, experience, or some other criteria, each group may be given a different assignment according to its identified educational needs.

MODULE T-6
CHOOSING APPROPRIATE RESOURCES FOR TECHNOLOGICAL SYSTEMS

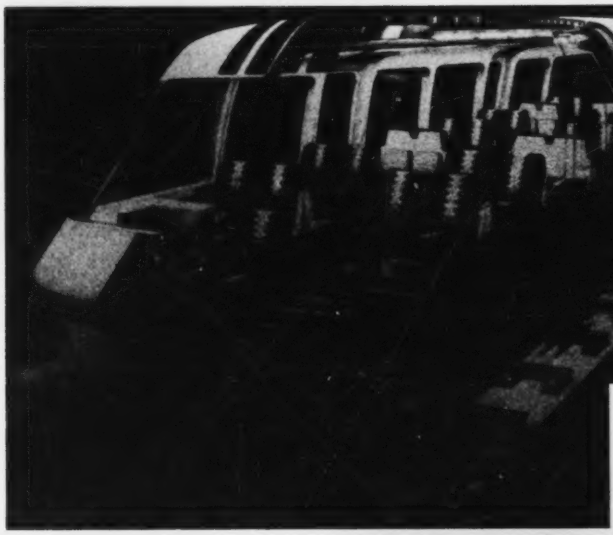
PREREQUISITES:

Modules: T-1 — T-5

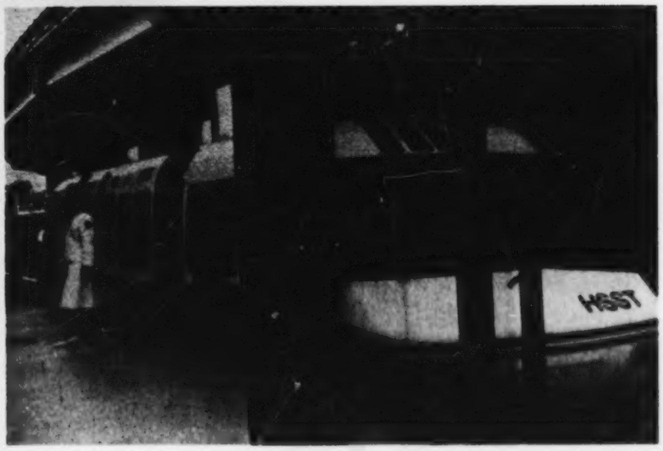
SUGGESTED TEACHING TIME:

3-5 Weeks

15-25 Forty-minute Periods



COURTESY: MICHAEL HACKER



U.S. DEPARTMENT OF ENERGY

MODULE T-6
CHOOSING APPROPRIATE RESOURCES FOR TECHNOLOGICAL SYSTEMS

OVERVIEW OF MODULE

GOAL

Using previous knowledge about technological resources, students will learn how to make informed choices in selecting the proper resources for technological systems. They will choose resources from each of the seven resource categories based upon criteria such as cost, availability, and appropriateness.

DESCRIPTION

To choose resources wisely, students must understand the use and limitations of each resource. Choices are made from among identified alternatives. These choices are influenced by such factors as cost, availability, and appropriateness. The selection of resources is also based upon considerations that limit the effects of negative impacts. Choices are constrained by limitations such as the properties of materials and scientific principles like gravity and the speed of light.

The process of obtaining a solution to a problem that best satisfies all the criteria within the constraints is called optimization. Optimization of resources may require compromises. Less than ideal resources may have to be used in place of preferred ones in order to remain within constraints such as cost, safety, and potential negative impacts. Such compromises are called tradeoffs.

Choosing appropriate resources for technological systems is a necessary step in finding the best solution to a problem. The computer is used to input data and access information about resources to help students make more informed decisions.

ENABLING VOCABULARY

Definitions will be found in the Technology Education glossary of terms.

ACCESS

APPROPRIATE RESOURCE

COMPROMISE

COMPUTER

COMPUTER HARDWARE

COMPUTER SOFTWARE

CONSTRAINTS

CRITERION, CRITERIA (pl)

DATA

GRAPHICS

OPTIMAL

OPTIMIZATION

PROFITABILITY

RENEWABILITY

RESOURCES

SCIENTIFIC PRINCIPLES

TRADE-OFF

MAJOR CONCEPTS TO BE DEVELOPED

T-6 A. Resources used in solving technological problems are chosen from each of the seven resource categories.

T-6 B. In choosing resources, a broad familiarity with available resources and their properties is necessary.

T-6 C. Resources are tentatively chosen in the early stages of technological problem solving based upon identified goals.

T-6 D. Important factors in choosing resources are availability, cost, and appropriateness.

T-6 E. Information, a resource that includes numbers, graphics, and words, can be accessed through the use of computers.

T-6 F. In choosing resources, human and natural constraints and limitations must be considered.

T-6 G. Optimization, the process of choosing the best combination of resources to solve a problem, often requires compromises and tradeoffs.

PERFORMANCE OBJECTIVES/ SUPPORTING COMPETENCIES*

1. Given a problem situation in each of the three aspects of technology and a desired goal, the student will identify needed resources and a range of possible alternative resources that can be used to solve the problem and achieve the desired goal.**

   In order to do this, the student must be able to:
   a. Identify needed resources.
   b. Gather information about the resources identified.
   c. Analyze the suitability of alternatives for the resources.
   d. Determine the most promising resources from among the alternatives.

2. Given specific instruction and access to the necessary equipment, tools, instruments, and materials, the student will investigate the properties of various synthetic, raw, and biological materials through testing and will describe why materials are often chosen on the basis of their properties.

   In order to do this, the student must be able to:
   a. Identify a variety of materials to be tested.
   b. Determine testing methods.
   c. Describe various material testing procedures (e.g., moisture tests on grain, tests of computer software, compression tests).
   d. Record and evaluate results.

3. Given a functioning technological system (e.g., a greenhouse, a production line, a computer system), the student will substitute different resource inputs for those originally provided in order to optimize system outputs within given constraints.

   In order to do this, the student must be able to:
   a. Identify the properties or attributes of given resources.
   b. Determine the availability of resources.
   c. Describe the possible impacts of substituting each resource.
   d. Record changes in outputs as a result of the substitution of resources.
   e. Judge the appropriateness of each resource.
   f. Use materials, tools, instruments, equipment, and procedures safely in the laboratory to substitute resources.

4. Given a situation relating to one or more of the performance objectives above, the student will use the computer and appropriate computer software to access data about the resources.

   In order to do this, the student must be able to:
   a. Identify software programs for specific applications such as word processing, database management, graphics, and telecommunication.
   b. Select an appropriate program for the task.
   c. Use the computer and software.

SUGGESTED INSTRUCTIONAL STRATEGIES

Instructional strategies may be homework assignments, classroom activities, or laboratory work. Those strategies to be implemented in the laboratory should be developed according to the Technology Learning Activity (TLA) format. In all cases, a variety of approaches for instruction and evaluation should be used to address the needs of individual students.

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*All student performance objectives have been written without specific evaluative criteria. It is expected that teachers will specify minimum performance levels consistent with the ability levels of their groups.

**Throughout this curriculum, "aspects of technology" shall be intended to mean biologically related, information/communication, and physical technologies.

1. Choose the most appropriate resources in order to design and build a shelter/domicile to accommodate a specific type of plant or animal or a person with a handicapping condition.
2. Choose the most appropriate resources in order to design and build a carrying device with consideration for the principles of ergonomics.
3. Design a message that will communicate effectively to persons not of our world and therefore not familiar with our written language or a message using Braille or signing.
4. Design or redesign a transportation system based upon appropriate vs. inappropriate use of resourses.
5. Design a musical instrument after having chosen appropriate resources.
6. Use the computer as a tool for conducting a search of available resources, or to process data about resources.
7. Use the computer in the design of a product.
8. Given a functioning greenhouse, change light levels, moisture, heat, and nutrients in order to optimize plant growth.
9. Using a functioning production line, change materials, tools, energy sources, procedures, people, time, and/or facilities in order to optimize production of a product.*
10. List career and training requirements for people involved in resource management.*
11. Using toys, sports equipment, and other devices, analyze the intended function of the products and redesign a chosen product to eliminate any problems encountered.
12. Test a variety of adhesives to determine the best one for a given fastening job.
13. Use data collection sheets to gather information about energy use in the home and then use the computer to do an energy audit.
14. Debate the appropriateness of nuclear power for the generation of electricity.*
15. Debate the appropriateness of using resource recovery plants to replace other methods of waste disposal.*
16. Conduct youth leadership organization fund raising to provide the capital resources necessary for production of a sucessful product.*
17. Encourage individual students to develop a sucessful and profitable enterprise.*

SUGGESTIONS FOR MODIFYING INSTRUCTIONAL TECHNIQUES OR MATERIALS

1. Provide brief, sequential written and oral directions for students with special needs. Have students develop a checklist where instructional activities include several steps. As each step is completed, students should check it off.

2. Ensure that adaptive devices for computers are available to allow participation of students with handicapping conditions.

3. Pair the student with a handicapping condition with another student during hands-on activities.

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*These strategies promote leadership qualities such as communication skills, decision-making abilities, problem-solving abilities, management skills, the ability to motivate others, and understanding of human relationships.

MODULE T-7
HOW RESOURCES ARE PROCESSED BY TECHNOLOGICAL SYSTEMS

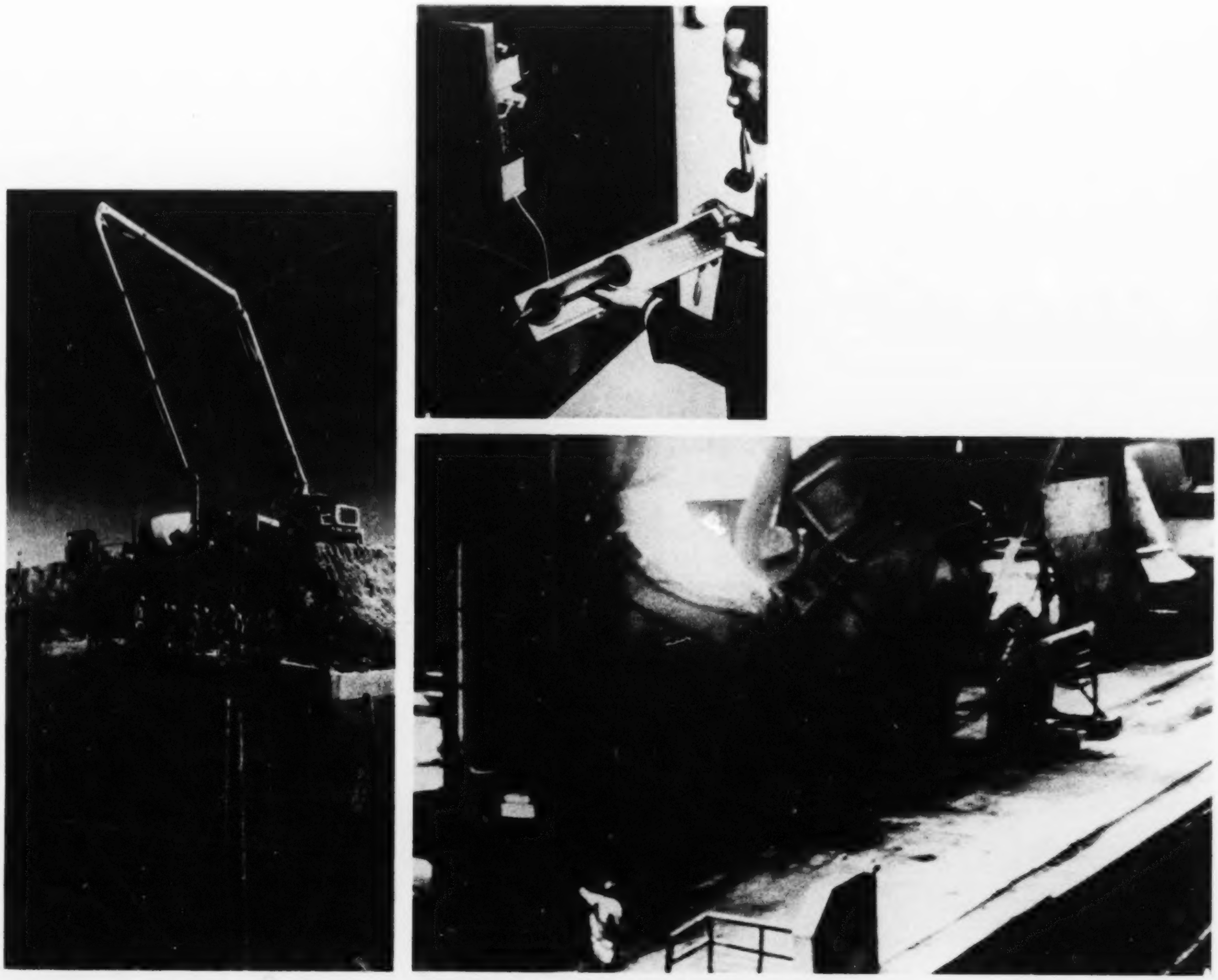
PREREQUISITES:

Modules T-1 — T-6

SUGGESTED TEACHING TIME:

3-5 Weeks

15-25 Forty-minute Periods



COURTESY: AMERICAN IRON AND STEEL INSTITUTE

MODULE T-7
HOW RESOURCES ARE PROCESSED BY TECHNOLOGICAL SYSTEMS

OVERVIEW OF MODULE

GOAL

In this module, students will learn how resources are processed by technological systems to meet human wants and needs and to solve problems. Students will study the conversion of energy, information, and materials from one form to another. Students will perform resource conversion in physical, biologically related, and information/communication technologies.

DESCRIPTION

The resources present in any technological system include people, information, materials, tools and machines, capital, energy, and time. Every technological system includes resources that are processed and combinations of resources that do the processing.

Students learn that people develop systems which process resources in order to convert them into useful end products and services. End products become new forms of energy, information, and materials. Regardless of the final form taken by the end product, energy, information, and materials must be processed and people using knowledge, capital, tools, machines, and time usually direct the processing. Although some systems have been automated to the point that direct human involvement may not be readily apparent, the role of the human designer is evidenced by the combination of resources that make up the system.

In this module, students will learn that the computer is a versatile tool that can be used for communication, to process information, and to control other tools or machines.

ENABLING VOCABULARY

Definitions will be found in the Technology Education glossary of terms.

AUTOMATION

COMPUTER CONTROL

COMPUTER SOFTWARE

CONVERSION

END PRODUCT

ENERGY CONVERSION

INFORMATION

INFORMATION PROCESSING

MATERIALS CONVERSION

MAJOR CONCEPTS TO BE DEVELOPED

T-7 A. Technological systems convert resources into end products which become new forms of energy, information, and/or materials.

T-7 B. The conversion of resources is usually directed by humans who develop technological systems.

T-7 C. The actual conversion of resources occurs within the process component of a technological system.

T-7 D. The results of conversion processes within a technological system should be monitored and the processes adjusted if the command input and system output are to match one another.

T-7 E. Computers as tools are used for information processing, communication, and system control.

PERFORMANCE OBJECTIVES/ SUPPORTING COMPETENCIES*

1. Given access to appropriate resources, the student will perform a variety of traditional and modern material conversion processes within each of the aspects of technology.**

   In order to do this, the student must be able to:
   a. Identify examples of traditional and modern material conversion processes.
   b. Identify the resources needed for specific material conversions.
   c. Describe the nature of the material change and the outputs that result from the conversion processes.
   d. Use materials, tools, instruments, equipment, and procedures safely in traditional and modern material conversion processes.

2. Given access to the necessary resources, the student will process information and communicate a message using graphic, photographic, or electronic means.

   In order to do this, the student must be able to:
   a. Identify the resources needed for processing and communicating specific information.
   b. Cite examples of graphic, photographic, and electronic means of communicating information.
   c. Describe the process of information change and the outputs that result from each communication system.
   d. Use materials, tools, instruments, equipment, and procedures to process information and communicate a message.

3. Given access to the necessary resources, the student will perform a variety of energy conversion processes within each of the aspects of technology.

   In order to do this, the student must be able to:
   a. Identify the resources needed for specific energy conversion processes.
   b. Describe energy inputs and the outputs that result from the conversion processes.
   c. Cite examples of energy conversion within each of the three aspects of technology.
   d. Use materials, tools, instruments, equipment, and procedures safely in a laboratory situation.

4. Given access to computer software and hardware and a problem with several variables related to objective 1, 2, or 3 above, the student will process information to reach a more informed decision.

   In order to do this, the student must be able to:
   a. Define the given problem clearly.
   b. Identify the computer as a tool which people use to process information and to assist in making decisions.
   c. Operate a computer system using the software selected.
   d. Analyze computer system outputs to make a more informed decision.

SUGGESTED INSTRUCTIONAL STRATEGIES

Instructional strategies may be homework assignments, classroom activities or laboratory work. Those strategies to be implemented in the laboratory should be developed according to the Technology Learning Activity (TLA) format. In all cases, a variety of approaches for instruction and evaluation should be used to address the needs of individual students.

1. Have the school nurse demonstrate devices to monitor blood pressure, breathing, temperature, pupil dilation, hearing, and other bodily functions as examples of biological processes that yield information.

2. Generate methane from biomass as an example of a biologically related conversion that yields materials.

3. Describe how a plant's growth or person's activity level is influenced by the nutrients received.

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*All student performance objectives have been written without specific evaluative criteria. It is expected that teachers will specify minimum performance levels consistent with the ability levels of their groups.

**Throughout this curriculum, "aspects of technology" shall be intended to mean biologically related, information/communication and physical technologies.

4. Implement communication systems to send messages for human communication (e.g., semaphore flags, sign language, telephones, telegraph, fiber optics) and describe which system is best for a given communication purpose.

5. Convert wind speed information into wind-chill information by using a computer or designing a wind-chill-factor meter.

6. Illustrate how time affects processes in the three aspects of technology by using time-lapse and high speed (strobe lights) photography.

7. Using fruits, vegetables, zinc, copper, and wires, create voltaic cells that produce electricity.

8. Using newspapers, periodicals, classroom, and laboratory experiences, plan, organize, and develop a bulletin board or technology newsletter.*

9. Produce and use several types of composite materials such as plywood or concrete.

10. Assemble and demonstrate a device which converts solar energy to electricity.

11. Construct and test a thermocouple.

12. Construct a product to demonstrate materials processing concepts. Examples would include finishing or fastening as examples of addition; sawing or shearing as examples of separation; processing and printing a roll of film as an example of internal change; and casting or molding as examples of contour change.

13. Construct and demonstrate a working model of a water wheel, wind generator, or windmill.

14. Use the computer to process raw data into more useful and presentable forms.

15. Visit a sawmill.*

16. Prepare a speech or demonstration on processing resources.*

17. Participate in Technology Quiz Bowl or other learning games.*

18. Participate in youth leadership organization technical skills contests.*

SUGGESTIONS FOR MODIFYING INSTRUCTIONAL TECHNIQUES OR MATERIALS

1. Explain theories thoroughly. Provide practical illustrations and simplify vocabulary when possible.

2. Special needs students may require additional review and reinforcement of learned material. Request that the student's special education teacher provide supplemental instruction.

3. Provide students with an outline of key concepts included in the module. This can serve as a study guide during the instructional period.

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*These strategies promote leadership qualities such as communication skills, decision-making abilities, problem-solving abilities, management skills, the ability to motivate others, and understanding of human relationships.

MODULE T-8
CONTROLLING TECHNOLOGICAL SYSTEMS

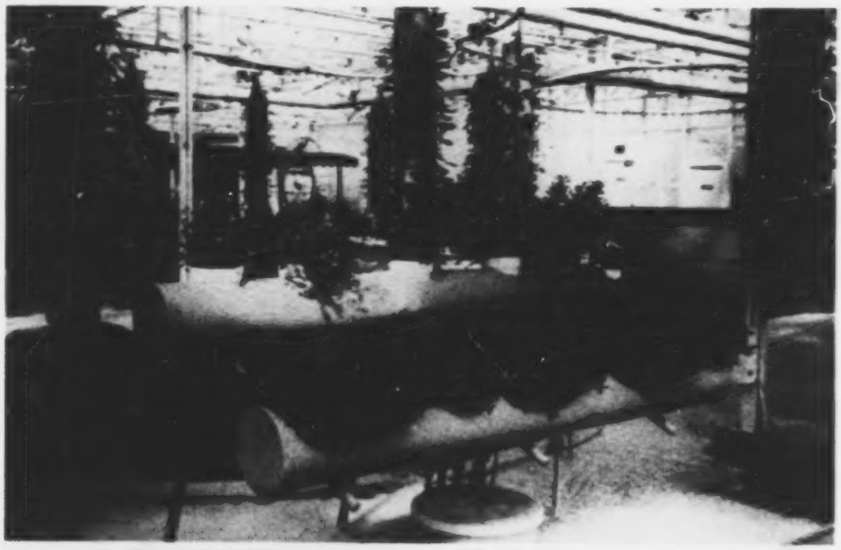
PREREQUISITES:

Modules: T-1 — T-7

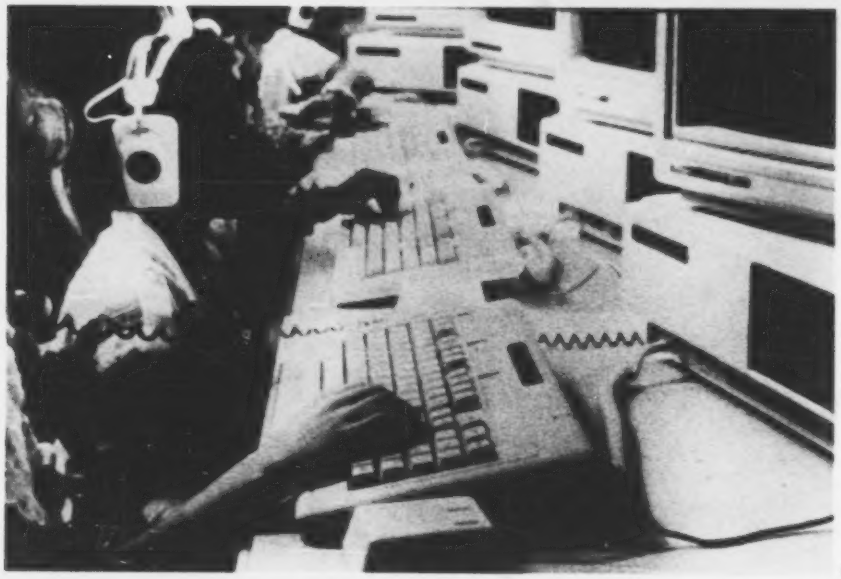
SUGGESTED TEACHING TIME:

3-5 Weeks

15-25 Forty-minute Periods



COURTESY: HENRY HARMS



COURTESY: TANDY CORPORATION

MODULE T-8
CONTROLLING TECHNOLOGICAL SYSTEMS

OVERVIEW OF MODULE

GOAL

This module is designed to provide students with an understanding of how technological systems are controlled. Students will learn that systems in biologically related, information/communication, and physical aspects of technology can be controlled by feedback in closed-loop systems or by subsystems such as timers or computer programs in open-loop systems.

DESCRIPTION

In this module, students will compare the operation of open-loop and closed-loop systems. Open-loop systems can not adjust to changing conditions. Closed-loop systems can correct for changing conditions to maintain the desired output. All closed-loop systems have a feedback loop that includes a sensor to monitor system output, a comparator to compare the output with the input, and a controller to adjust the process.

Students will learn that sensors can be human or technological and will demonstrate that humans can use their senses to monitor the output of a technological system. The use of technological control systems as a replacement for human control is also studied.

In this module, students will use a computer system to control the operation of a technological system.

ENABLING VOCABULARY

Definitions will be found in the Technology Education glossary of terms.

ACTUAL RESULT

ADJUSTMENT

CLOSED-LOOP SYSTEM

COMPARISON DEVICE

DESIRED RESULT

ELECTRO-MECHANICAL

HYDRAULICS

MONITOR

OPEN-LOOP SYSTEM

PNEUMATICS

PROGRAM

SENSOR

SUBSYSTEM

MAJOR CONCEPTS TO BE DEVELOPED

T-8 A. Some open-loop systems are programmed to achieve desired outcomes but are unable to adjust to changing conditions.

T-8 B. Sensors can be used to provide feedback about the presence or absence of a desired condition.

T-8 C. Closed-loop systems use feedback to overcome the inability of an open-loop system to adjust to changing conditions.

T-8 D. Closed-loop systems are designed to automatically adjust the control signal which modifies the process component. Thus, desired outcomes (within limits) can be achieved even if conditions change.

T-8 E. A technological system is controlled by: (a) sensing the output of the system, (b) comparing the sensed output with the command input, (c) making adjustments to control the process to better match actual output to the command input.

T-8 F. Computer systems can be assembled, programmed, and operated to perform open-loop and/or closed-loop tasks.

PERFORMANCE OBJECTIVES/ SUPPORTING COMPETENCIES*

1. Given the necessary resources, the student will graphically describe examples of open loop and closed-loop systems in each of the three aspects of technology.**

   In order to do this, the student must be able to:
   a. Differentiate between open-loop and closed-loop systems.
   b. Draw a block diagram of an open-loop system with program control.
   c. Draw a block diagram of a closed-loop system.

2. Given the necessary resources, the student will demonstrate the use of human and technological sensors to monitor the output of a process.

   In order to do this, the student must be able to:
   a. Differentiate between human and technological sensors.
   b. Demonstrate how a person can use his/her sense of sight, smell, touch, taste, and hearing to monitor the output of a technological system (e.g., toaster, traffic control, heating, smoothness of a finish, quality of a stereo system, food tasting).
   c. Explain how a technological sensor is used in a system (e.g. thermostat, float, photocell, moisture sensor).
   d. Use materials, tools, instruments, equipment, and procedures safely in a laboratory setting.

3. Given plans and access to the necessary equipment and resources, the student will assemble and operate a closed-loop technological system.

   In order to do this, the student must be able to:
   a. Describe how humans can make comparisons of actual results of a process to the desired results.
   b. Demonstrate how subsystems can be used as comparison devices (e.g., thermostat, photocell switch, sonar focusing in cameras).
   c. Explain how the system is controlled by feedback (i.e., by electronic, mechanical, hydraulic, and/or pneumatic devices).
   d. Use materials, tools, instruments, equipment, and procedures safely to assemble and operate a closed technological system.

4. Given plans and the necessary hardware and software tools, the student will use a computer to control a technological system.

   In order to do this, the student must be able to:
   a. Assemble a computer-controlled technological system.
   b. Program or input an existing program and operate a computer-based system to follow a sequence of steps or instructions.

SUGGESTED INSTRUCTIONAL STRATEGIES

Instructional strategies may be homework assignments, classroom activities, or laboratory work. Those strategies to be implemented in the laboratory should be developed according to the Technology Learning Activity (TLA) format. In all cases, a variety of approaches for instruction and evaluation should be used to address the needs of individual students.

1. Construct a closed-loop electronic system which heats a small space to a specific temperature; e.g., a fish tank or kiln.

2. Discuss and analyze an environmental control system for a medical facility or a school. Discuss how persons with disabilities use control systems to monitor their medical needs.*

3. Construct a computerized motor control system using a DC motor, photocell, and slotted disk for measuring

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*All student performance objectives have been written without specific evaluative criteria. It is expected that teachers will specify minimum performance levels consistent with the ability levels of their groups.

**Throughout this curriculum, "aspects of technology" shall be intended to mean biologically related, information/communication and physical technologies.

speed. The slotted disk and photocell would be used to measure the motor's speed.

4. Construct and operate a soil moisture control system. This experience could be used to study the germination of seeds under different soil and moisture conditions.

5. Have an agriculture expert speak to the class about innovations in soil moisture control.

6. Construct a series of experimental stations for studying a computer's ability to recognize changes in the environment with various sensors; e.g., light, water level, temperature, pressure, sound.

7. Construct a light system which maintains a specific intensity of light to a sensor even though light filters and reflectors are introduced.

8. List career fields which involve the production, monitoring, or control of light.*

9. Construct a system which controls the speed of a moving vehicle or object.

10. Construct and test a bimetallic thermostat.

11. Construct a float-controlled valve for fluid control.

12. Construct and demonstrate a variety of methods of sensing liquid levels.

13. Construct a simple GSR (Galvanic Skin Response) measuring system to determine how stress causes changes in the body's skin resistance.

14. Use high technology toys such as Big-Trak and programmable robots to illustrate the concepts of control and adjustment.

15. Model a system that will turn a street light on at dusk and off at dawn.

16. Model a computer-controlled traffic light system. Add a pedestrian-operated crosswalk switch to adjust control.

17. Operate a line tracer robot to demonstrate feedback control.

18. Operate a model robotic arm manually and by computer control.

19. Structure a debate which questions whether humans should prevent the development of technologies such as genetic engineering or medical research on animals.*

20. Use a motorized wheelchair to demonstrate the concepts of control and adjustment.

SUGGESTIONS FOR MODIFYING INSTRUCTIONAL TECHNIQUES OR MATERIALS

1. Some students with handicapping conditions may need extra assistance or support for activities involving fine motor coordination (e.g., constructing a system in a small space, using seeds). It may be helpful to allow such students additional time or provide tools which would assist in grasping small items.

2. Some students may need the experimental stations more structured. An outline of steps to take or pairing up with another student would be helpful.

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*These strategies promote leadership qualities such as communication skills, decision-making abilities, problem-solving abilities, management skills, the ability to motivate others and to understand human relationships.

MODULE T-9
TECHNOLOGY AND SOCIETY: NOW AND IN THE FUTURE

PREREQUISITES:

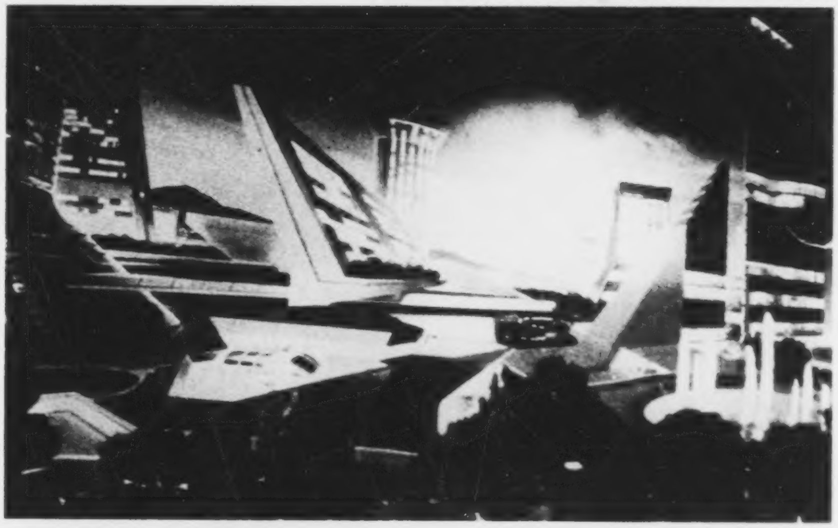
Modules T-1 — T-8

SUGGESTED TEACHING TIME:

2-3 Weeks

10 Forty-minute Periods

COURTESY: GENERAL ELECTRIC COMPANY



COURTESY: BRITISH AMERICAN TRAVEL OFFICE

COURTESY: DREXLER TECHNOLOGY

MODULE T-9
TECHNOLOGY AND SOCIETY: NOW AND IN THE FUTURE

OVERVIEW OF MODULE

GOAL

This module is designed to provide students with an understanding of the impacts of technology on society from a local, national, and global perspective. Students will assess current and future technological systems in terms of their social as well as environmental impacts.

DESCRIPTION

A sociocultural understanding of technology is as important as understanding its technical side. In the future a whole new set of needs and wants for individuals and society will have to be addressed. The skills and knowledge needed by students being prepared for careers and society of the future must be explored.

Today's students must learn that they need to become futurists in order to look beyond their current scope of choices in working to solve personal, social, or technological problems. Some of these problems will be generated by new technologies. People will face currently unknown choices and challenges in the world of work as well as the possibility of increased leisure time and the need to use it constructively.

Technological advances have improved the quality of life for many persons, especially those with handicapping conditions. These technologies can, for example, assist persons to speak who could not otherwise do so, assist persons who do not have sight to read printed materials, and assist persons to work at jobs that they otherwise could not do.

In this module, students will also study the global nature of technological systems. Technology can create world social problems but can also be used to solve them. The threat of destruction by the weapons of war, decline in the quality of water and air, and depletion of natural resources are some of the societal problems that technology has contributed to. The development of new food sources, production techniques, and other benefits made possible by advanced and emerging technologies must be utilized to solve world social problems today and in the future.

Technology has made all societies of the world interdependent. Complex problems have become international in nature and must be viewed as global problems. Solutions to these problems will require international cooperation and sharing of resources and expertise. The intelligent control of technology can be achieved by being able to anticipate the impacts of technological systems in order to plan solutions to the increasingly complex problems that future societies of the world will face.

ENABLING VOCABULARY

Definitions will be found in the Technology Education glossary of terms.

ADAPTABILITY

CAREER

CAREER CLUSTER

EXPERTISE

FUTURIST

GLOBAL

INTERDEPENDENCE

MARKET

TRANSFERABLE SKILLS

TREND ANALYSIS

MAJOR CONCEPTS TO BE DEVELOPED

T-9 A. Technological systems must be assessed on the basis of their impact on people, society, and the environment.

T-9 B. Technological evolution can be projected into the future world.

T-9 C. As emerging technologies replace existing technologies, new industries will develop.

T-9 D. Work, job opportunities, and careers are in constant change because of the evolution of technology.

T-9 E. The development of flexible attitudes and transferable skills will increase the adaptability of persons to the rapid evolution of technology.

T-9 F. The development of leadership and social skills allows individuals to pursue technological careers with higher levels of responsibility.

T-9 G. Technology has an impact on personal, local, national and international issues. These impacts, whether perceived or actual, may take many forms.

T-9 H. The rapid spread of technology has created world competition for jobs, resources, and markets.

T-9 I. Technology is making the world interdependent, resulting in the need for more international cooperation by sharing things such as resources, technical expertise, and markets.

T-9 J. Technological systems must be controlled for the continued well-being of the world.

PERFORMANCE OBJECTIVES/ SUPPORTING COMPETENCIES*

1. Given an example of a technological system in each of the aspects of technology, the student will use futuring techniques to anticipate the consequences of a new technology.**

   In order to do this, the student must be able to:
   a. Understand the role of people as futurists.
   b. Identify futuring techniques such as trend analysis and evolutionary timelines to the future.
   c. Identify emerging technologies in the three aspects of technology.
   d. Identify socio-technological impacts on a local, national, and global level.

2. Given examples of emerging technologies in each of three aspects of technology, the student will describe how these technologies have created new jobs while making others obsolete.

   In order to do this, the student must be able to:
   a. Explain the relationship of rapidly changing technology to global competition and jobs.
   b. Describe specific jobs that have been created or made obsolete by emerging technologies.
   c. Identify changes in society that are the result of changes in jobs.
   d. Describe an educational program appropriate to the requirements for one job such as technician, engineer, or technology education teacher.
   e. Define transferable skills and flexible work attitudes.
   f. Identify the transferable skills that might be necessary for continued employment.

3. Given an example of a local issue, a national issue, and a global issue, the student will propose alternative technological solutions to each issue and model one of the alternatives.

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*All student performance objectives have been written without specific evaluative criteria. It is expected that teachers will specify minimum performance levels consistent with the ability levels of their groups.

**Throughout this curriculum, "aspects of technology" shall be intended to mean biologically related, information/communication and physical technologies.

In order to do this, the student must be able to:

a. Describe the underlying basis for selected local, national, and global social issues.
b. Describe technologies or impacts of technologies which have created social issues, e.g., embryo transfer, nuclear power, acid rain.
c. Suggest alternative solutions to a technology that creates negative impacts.
d. Identify the specific technological resources needed to implement the solution to the identified issue.
e. Employ modeling techniques.
f. Use materials, tools, instruments, equipment, and procedures safely in a laboratory setting.

SUGGESTED INSTRUCTIONAL STRATEGIES

Instructional strategies may be homework assignments, classroom activities or laboratory work. Those strategies to be implemented in the laboratory should be developed according to the Technology Learning Activity (TLA) format. In all cases, a variety of approaches for instruction and evaluation should be used to address the needs of individual students.

1. Design and construct a board game called "committee on world repair." Questions dealing with world impacts of technology and cards that represent problem situations, such as drought, typhoon, and other natural occurrences could be included. Computer generated graphics may be used for the game board squares and word processing for the questions.

2. Using past science fiction stories such as the work of Jules Verne, identify and list the technologies that did not exist at the time the stories were written. Compare the list with our present technology to see if the science fiction of the past has become the fact of today. This could also be done with contemporary science fiction, identifying the projected technologies of the future and their societal impacts on the world.

3. Using the theme of sports, investigate how technology has affected the equipment, training, rules, and societal perception of athletic competition on amateur and professional levels. Some topic suggestions are: physical technologies — metal alloy bats, break away rims; in the area of biologically related technology — steroids, blood loading, drugs; and in information/communication technology — instant replay officiating. An oral group presentation or written reports could be assigned on these topics.

4. Review current literature to identify emerging technologies and predict potential impacts on individuals and the environment. Include technologies which can assist persons with disabilities. Make brief presentations to the class.*

5. Use a CAD system and compare it to the traditional method for mechanical drawing.

6. Model a series of devices that together show signficant changes in technology from 1900 to the present in one of the following areas: information/communication systems, transportation systems, biotechnical systems, or production systems. Identify social changes.

7. Discuss the impacts on a community when its largest employer closes or relocates.*

8. Several local and global issues which involve energy management can be related to laboratory activity. Improvement of understanding among people in different countries, pollution, nuclear power, and waste management are examples. Construction of solar devices, windmill models, power plant models, greenhouses, recycling devices, and cities of the future are all potential activities.

9. Form a photographic exchange with students in other countries. Each group of students should be asked to photograph the world they know with particular emphasis on technologies that influence their daily living. Arrangements may be made through the United Nations or the World Future Society.

10. Amateur radio communications is an excellent way of fostering improved international understanding. Information on this type of activity can be obtained from: The American Radio Relay League, Newington, CT 06111.

11. Have a local youth leadership organization sponsor a job interview competition or career day.*

12. Present a 3-5 minute speech on a career field. Have students role play different occupations that are nontraditional for their sex.

13. Research or participate in laboratory activities that look at emerging technologies such as robotics, lasers, or satellite communications and adaptations for persons with disabilities. Students should be encouraged to write or call high technology companies as well as do library research. Report back to the class on the following aspects of the new technology: a) the current state of the technology, b) impacts the technology is having on society, c) career opportunities, d) an estimate of what the technology might look like ten years in the future, e) educational requirements for entry into the career field, f) entry level salaries.

14. Given an example of an existing technological system, the student will develop an adaptation of that system which will work in a setting other than the one for which the original system was designed.

15. Identify jobs that have been eliminated and created by the increased use of high tech tools such as computers and robots.

16. Write a short career outline on medical careers which use new technologies to diagnose and treat medical problems.

17. Discuss how technology has helped to make the world a global village.

18. View the film "War Games" and discuss the local, national, and world implications of using artificial intelligence to make important decisions.

19. Interview grandparents or others at least two generations removed to determine ways in which their lives have been changed by technology. Present findings to the class in some organized manner.*

20. Engage in activities related to closing a solid waste landfill. Possible activities include recycling of aluminum, glass, or paper; collection and use of methane gas; and the design and modeling of recreational facilities to be built at the closed landfill site.

21. Design and make posters or bumper stickers to increase public awareness of technological issues such as energy conservation, acid rain, nuclear power.

22. Propose solutions to problems created by overpopulation such as constructing models of modular housing, controlled environment agriculture, and space or underwater habitats.

23. Discuss the impacts of global competition for resources and markets.*

24. Debate the use of life support technology for the critically ill.*

SUGGESTIONS FOR MODIFYING INSTRUCTIONAL TECHNIQUES OR MATERIALS

1. During lab sessions, allow a student to observe another student in the class and record the steps taken to complete a task.

2. Have students dictate research notes if writing is difficult.

3. Capitalize on individual abilities. If a student appears to be mechanically inclined, encourage hobbies for extra credit assignments.

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*These strategies promote leadership qualities such as communication skills, decision-making abilities, problem-solving abilities, management skills, the ability to motivate others and to understand human relationships.

MODULE T-10
USING SYSTEMS TO SOLVE PROBLEMS

PREREQUISITES:

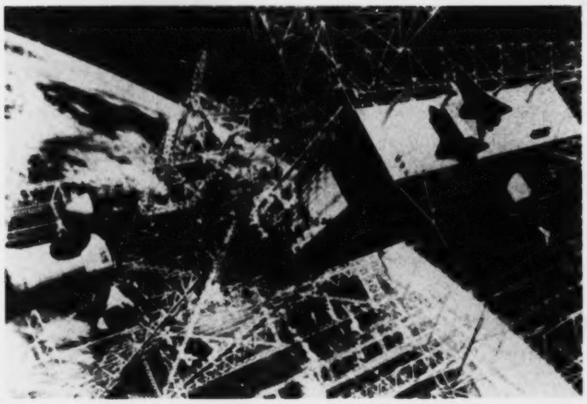
Modules: T-1 — T-9

SUGGESTED TEACHING TIME:

4-6 Weeks

20-30 Forty-minute Periods

COURTESY: LEGO SYSTEMS INC.



COURTESY: BOEING AEROSPACE CORPORATION

MODULE T-10
USING SYSTEMS TO SOLVE PROBLEMS

OVERVIEW OF MODULE

GOAL

The purpose of this module is to provide the students with an opportunity to apply their knowledge of systems. The students will use the systems approach to solve problems in biologically related, communications/information, and physical technology. In addition, students will combine various subsystems to provide integrated solutions to realistic problems or challenges.

DESCRIPTION

This module is intended to be a synthesizing experience that challenges the student to solve an original problem creatively. Students learn how to use the systems model to aid in the problem-solving process, thus providing them with an effective problem-solving tool. Students then use the problem-solving process to design and develop an operating technological system.

Students will use the computer to keep records, to document their progress, and to make decisions based on input data as they relate to the technological problem.

ENABLING VOCABULARY

Definitions will be found in the Technology Education glossary of terms.

DESIGN

DOCUMENTATION

SYNTHESIS

MAJOR CONCEPTS TO BE DEVELOPED

T-10 A. The same systems model which is used to diagram individual technologies is an effective problem-solving tool.

T-10 B. The solutions to practical problems often involve a combination of subsystems from different aspects of technology.

T-10 C. Computers, as tools, can be used to store and retrieve information.

T-10 D. Computers are tools which may be used by people to help decide upon a solution to a problem as well as to implement a solution to a problem.

PERFORMANCE OBJECTIVES/ SUPPORTING COMPETENCIES*

1. Given a problem in each of the aspects of technology, the student will draw and label a systems diagram which depicts the systems approach to developing a solution to the problem.**

   In order to do this, the student must be able to:
   a. Relate the problem-solving model in module T-3 to the basic systems model.
   b. Describe command inputs.
   c. Propose a process.

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*All student performance objectives have been written without specific evaluative criteria. It is expected that teachers will specify minimum performance levels consistent with the ability levels of their groups.

**Throughout this curriculum, "aspects of technology" shall be intended to mean biologically related, information/communication and physical technologies.

   d. List possible outputs.
   e. Identify a method to monitor the outputs.
   f. Compare the command input to the system output.
   g. Describe ways of adjusting the system outputs.

2. Given a technological problem and access to the necessary equipment and resources, the student will use a systems approach to develop a technological solution.

   In order to do this, the student must be able to:
   a. Use a formal problem-solving approach.
   b. Explain how several common systems (electronic, mechanical, hydraulic, and/or pneumatic) are monitored and controlled by feedback.
   c. Create block diagrams, sketches, and drawings of original technological systems that include the components necessary to monitor and control the systems.
   d. Use materials, tools, instruments, equipment, and procedures safely in a laboratory setting to create an operating technological system.

3. Given the problem proposed in performance objective 2 above, the student will use the computer as a record keeping device to document progress toward reaching an optimal solution to the problem.

   In order to do this, the student must be able to:
   a. Record information such as the resources and processes used.
   b. Record mathematical and other technical data.
   c. Analyze and record system output data.
   d. Select appropriate software to store information and data.
   e. Output the processed information to a printer or other recording device.

SUGGESTED INSTRUCTIONAL STRATEGIES

Instructional strategies may be homework assignments, classroom activities or laboratory work. Those strategies to be implemented in the laboratory should be developed according to the Technology Learning Activity (TLA) format. In all cases, a variety of approaches for instruction and evaluation should be used to address the needs of individual students.

1. Construct a system to transmit information over a distance.

2. Construct a system to improve the air quality inside a room.

3. Build a self-regulating and/or solar tracking hot dog cooker.

4. Develop systems whose purposes could be altered by the substitution of different sensors or controls; e.g., build a system with an audible signal that can be converted from a smoke alarm to a temperature alarm to a water level alarm to an intrusion alarm.

5. Propose a problem that could be solved by systems which depend upon different sensors; e.g., a system for detecting fluid level may be implemented with mechanical, optical, electrical, pressure, and other types of sensors.

6. Use a computer modem and software to transmit a student prepared newsletter from one school to another.*

7. Design and construct a system to reduce the level of noise produced by a computer printer or other noisy device within the laboratory.

8. Design and construct a system that uses lights to aid a hearing impaired person communicate more effectively. Example would be a flashing green light to indicate someone is at the door.

9. Set up and use a digitizing video system to produce images for computer prepared reproduction.

10. Demonstrate a counting system that uses a laser or computer to monitor the flow of production.

11. Design a community service project which addresses a local technological problem.*

12. Work with a youth leadership organization to design and implement safety projects in the classroom, school, or community.*

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*These strategies promote leadership qualities such as communication skills, decision-making abilities, problem-solving abilities, management skills, the ability to motivate others and to understand human relationships.

SUGGESTIONS FOR MODIFYING INSTRUCTIONAL TECHNIQUES OR MATERIALS

1. Some students with handicapping conditions may require adaptive input devices such as an expanded keyboard, voice input, wobble sticks, or mouse devices.

2. Provide students with an overview of the major concepts involved with sensors and controls.

3. Provide a comprehensive list of terminology to the special education teacher to supplement instruction.

GLOSSARY OF TERMS

Note: This glossary is intended for use by the teacher. Depending upon the ability levels of the students, the teacher may have to rephrase some definitions for students.

ACTUAL RESULT - the realized output of a system. The actual result is usually monitored and compared to the desired result.

ADAPTABILITY - the result of a broad-based education providing career mobility.

ADJUSTMENT - a change in the process to cause the actual result (output) to conform to the desired result (input).

AESTHETICS - sensitivity to art and beauty.

AGRICULTURALLY BASED SOCIETY - a society whose economic system is based upon the production of plants and animals.

APPROPRIATE RESOURCE - a resource which is suitable for a particular application.

APPROPRIATE TECHNOLOGY - a technology that is suitable for a given human need or want within designated constraints.

ASSESSMENT - evaluation of a situation or problem after careful study.

ATTAINMENT OF GOAL - an acceptable match of the results of a process or system within the desired goal.

AUTOMATIC CONTROL - pre-programming a process to function without human intervention.

AUTOMATION - a method or technique involving self-regulation and self-control through feedback which permits a process to operate by the use of built-in supplementary controls within the system.

BASIC HUMAN NEEDS - biological, physical, and psychological well-being.

BIOFEEDBACK - the use of conscious awareness of bodily functions to exert some control over those functions.

BIOLOGICAL SYSTEM - systems contained within or composed of living organisms; *e.g.*, temperature control, respiratory system, digestive system, etc.

BIOLOGICALLY RELATED TECHNOLOGY - a broad and varied field of activity that encompasses the manipulation of biological materials by scientific, engineering, and technological methods to provide information, goods, and services. This term also refers to physical and/or information/communication technologies applied to biological systems.

BIOTECHNICAL SYSTEM - the interface of human developed processes and/or components with a biological system; *e.g.*, agriculture, medical technology, food processing and preservation.

BRAINSTORMING - a group idea-generation technique based on the premise that quantity of ideas will produce quality of ideas. The activity is performed in a non-critical atmosphere and a limited time frame. Participants are encouraged to generate ideas in rapid succession and to allow the input of other members to spark ideas within themselves. Evaluation of ideas is deferred until after the generation phase.

CAPITAL - a resource in the form of a commodity or currency (money) having value which can be used in exchange for other resources.

CAPITAL CONSTRAINTS - limitations imposed by a limited amount of commodity or currency for purchase of resources for the process.

CAREER - the occupation or work a person is engaged in.

CAREER AWARENESS - student knowledge of various career clusters, work requirements, and job-readiness skills.

CAREER CLUSTER - jobs which are related to a particular occupational category.

CAREER EXPLORATION - investigating the necessary preparation for jobs, opportunities for jobs, and potential for reward and fulfillment in various careers one might attempt to enter.

CLOSED-LOOP SYSTEM - a system that works on the basis of feedback which is used to control the system automatically or manually. Examples would be the utilization of a thermostat to monitor and adjust the home heating system, or homeostasis in living organisms.

COMMAND INPUT - a statement of the desired result of the system.

GLOSSARY OF TERMS

COMPARISON DEVICE - a subsystem or component which receives information from the main system's output sensors and compares this with the command input. This device provides the proper adjustment signal(s) to modify the system's process component.

COMPROMISE - an adjustment of conflicting demands or requirements in which something is given up on each side.

COMPUTER - an electronic tool used for information processing, communication, and control.

COMPUTER CONTROL - using a computer to guide or direct devices and processes.

COMPUTER HARDWARE - equipment used in a computer system, including the keyboard, disk drives, tape storage, central processing unit, monitor, printer, and modem.

COMPUTER SOFTWARE - computer programs (user or commercially developed) which instruct the computer to execute a specific task or tasks.

CONFLUENCE OF SYSTEMS - the joining together of two or more systems to form a new system. The original system becomes a subsystem of the new system.

CONSENSUS - general agreement.

CONSTRAINTS - limitations imposed by scientific principles or limited resources, or resulting from people's values and attitudes.

CONTROL - a method of regulating a system.

CONVERSION - the result of changes made through technological processes.

CRITERION - a standard, rule, or test by which a judgment of something can be made.

CULTURE - the values and ways of life of a particular group of people.

DATA - facts or figures which can be processed and from which conclusions may be formed.

DECISION MAKING - the process of identifying, analyzing, and choosing among alternatives and usually followed by acting on and evaluating the results of the choice.

DEDICATED COMPUTER - a computer system that is designed for a single application; *e.g.*, a word-processing system.

DEFINE - to explain or make clear the meaning of a word, phrase, or task; this could include modeling, verbalization, demonstration, illustration, or production.

DEMAND - the degree to which a commodity or service is wanted at a specified price and time.

DEMONSTRATION - an outward expression or display; an act or process as a means of exhibiting skills, knowledge, or behaviors.

DESIGN - the plans or the process of planning an envisioned action, project, or product.

DESIRED RESULT - the intent or standard with which the actual output of the system is compared to determine if the results are correct; the goal.

DOCUMENTATION - written proof, supporting statements, or conclusions.

ECOLOGICAL SYSTEMS - self-regulating systems (closed-loop) involving the interaction of organisms and their environments, such as plant to plant, plant to animal, plant to environment, animal to environment, and animal to animal, with humans and technology affecting all components.

ELECTRO-MECHANICAL - a mechanical process or device that is controlled electrically.

ELECTRONIC MAIL - sending messages electronically from one computer terminal to another.

END PRODUCT - the output of a manufacturing system.

ENERGY - the ability to do work. Types of energy include radiant, mechanical, chemical, magnetic, electrical, acoustic, thermal, and light. Sources of energy are water, wind, nuclear, chemical, geothermal, solar, human and animal muscle, biomass, and fossil fuels.

ENERGY CONVERSION - changing one form of energy into another; *e.g.*, chemical energy from batteries into electrical energy.

ENGINEERING - practical application of science and mathematics.

GLOSSARY OF TERMS

ENVIRONMENTAL IMPACTS OF TECHNOLOGY - the effects upon the land, water, and air created by a technological system. Impacts can be positive as well as negative.

ERGONOMICS - human factors engineering; matching technology to human needs and characteristics.

ETHICS - moral principles or practices.

EVALUATE - to measure against a set of standards.

EXPECTED OR UNEXPECTED IMPACT - an expected impact is one which the system designer predicted, such as warm water discharge from a power generating plant. An example of an unexpected impact would be the thriving of certain species of fish around the water outlet because of the higher water temperature in the area.

EXPERTISE - specialized skill or technical knowledge.

FACILITATING DEVICE - a device which makes it easier for a handicapped person to accomplish a given task.

FEEDBACK - information obtained by monitoring the output which permits adjustments.

FINITE RESOURCES - see resources.

FUTURIST - an individual who projects possible future outcomes of a given system or situation and analyzes the effects of each outcome.

GENERIC - of a general nature; not specific to one thing.

GLOBAL - pertaining to the whole world.

GLOBAL DISTRIBUTION OF RESOURCES - the geographical distribution of natural resources across the globe.

GOAL SETTING - identifying the end toward which effort is directed.

GRAPHICS - a picture, map, or graph used for illustration or demonstration.

HUMAN-MADE ENVIRONMENT - an artificial environment such as a greenhouse.

HUMANISTIC - marked by compassion, sympathy, or consideration for others.

HYDRAULICS - operated or moved by means of water.

HYPOTHESIS - a tentative assumption made in order to draw out and test its logical consequences.

ILLUSTRATION - an explanation by graphic or an alternative method of representation. Illustration includes sketches, technical drawings, photographs, videotapes, computer graphics, graphic arts media, etc.

IMPACT - a consequence or result of some preceding action(s). Impacts may be desired or undesired, expected or unexpected.

IMPLEMENTATION - putting plans into action.

INDUSTRIALLY BASED SOCIETY - a society whose economy is based on industry.

INFLUENCE - to cause an effect without direct force or authority.

INFORMATION - data in a form that can be used for the purpose of communication or control.

INFORMATION-BASED SOCIETY - a society whose economy is based on information technologies.

INFORMATION/COMMUNICATION SYSTEMS - a coordinated set of data, procedures, people, and equipment that collects, processes, stores, and delivers information.

INFORMATION/COMMUNICATION TECHNOLOGY - the use of a device or method to collect, process, store, or deliver information utilizing electronic, graphic, photographic, and/or mechanical means.

INFORMATION PROCESSING - the act of converting information into new, more useful information or into knowledge.

INNOVATION - a new idea, process, or device.

INPUT - data, materials, resources, or instructions entered into a system.

INTERACTION - mutual action upon each other.

GLOSSARY OF TERMS

INTEGRATED SYSTEM - a system made up of smaller interacting subsystems.

INTERDEPENDENCE - the act of relying upon one another.

INTERDISCIPLINARY APPROACH - involving input from two or more academic disciplines.

INVENTION - a device or process originated after imagination, study, or experiment.

JOB DISLOCATION - the movement of jobs, people, and communities resulting from changing employment opportunities.

LABOR - physical or mental exertion; work.

LIFE CYCLE - the period of time from inception to cessation of functioning.

LONG-TERM IMPACTS - those impacts which are not immediately felt or realized, such as the effect of acid rain after 20 years.

MACHINE - a combination of parts used to change the amount, speed, or direction of a force.

MANUAL - involving the use of the human hand.

MANUFACTURING - production of tangible goods.

MARKET - a system of distribution for goods and services.

MATERIALS - any of a group of physical substances in solid, liquid, or gaseous form (natural, biological, processed, synthetic, renewable and nonrenewable).

MATERIALS CONVERSION - the processing of a material into a new material or end product.

MODELING - representation of an object or concept utilizing living or nonliving material (*e.g.*, working models, charts, graphs, technical drawings, sketches, illustrations, mathematical equations, computer simulations).

MODULE - a unit or section of a curriculum which serves as the basis of, or focus toward, a particular goal or set of goals.

MONITOR - the part of the feedback loop that has to do with observing the output of a system.

MONITORING - the process of observing the output of a system.

NATURAL SYSTEMS - systems which grow in the natural world with or without human cultivation (*e.g.*, plants and animals); also ecological systems which involve interaction among living organisms and between those organisms and their physical environment.

NEEDS - something required for biological, physical, and/or psychological well-being.

OCCUPATIONAL HEALTH - the prevention of work-related illnesses.

OCCUPATIONAL SAFETY - the prevention of work-related accidents.

OPEN-LOOP SYSTEM - a system that is pre-programmed (manually or automatically) to follow a fixed set of procedures; *e.g.*, alarm clock, microwave oven or dishwasher designed to run through a variety of fixed cycles, or the application of time-release medications to living organisms.

OPTIMAL - the best or most favorable conditions; an ideal.

OPTIMIZATION - the process of obtaining the solution that best satisfies all the criteria within the established constraints or limitations.

OUTPUT - the actual results of a system, desired or undesired, expected or unexpected.

PEOPLE - one of the seven resources. People supply knowledge as well as labor.

PERFORMANCE OBJECTIVE - a statement of a skill, knowledge, or attitude which is to be performed under stated conditions and to a stated standard.

PHYSICAL TECHNOLOGY - technology that involves the construction or production of products made from nonliving material(s). Also the transportation of living and nonliving materials and the production and distribution of energy.

PNEUMATICS - using air pressure to activate mechanical devices.

GLOSSARY OF TERMS

PRE-PROGRAMMING - setting the operating steps in a program in advance so that when the system is turned on it will run by itself.

PROBLEM - a question posed for consideration or in need of a solution.

PROBLEM SOLVING - the process of identifying, selecting, trying out, and evaluating alternative solutions that will fulfill a desired goal.

PROCESS - the action component of a system; the combining of resources into actual results (output) which fulfills the desired goal (command input).

PRODUCTION - a method of converting, combining, and/or using resources for the purpose of constructing, manufacturing, or growing something.

PRODUCTION SYSTEM - resources and procedures used by people to create desired outcomes through manufacturing, construction, energy conversion, and the growing of plants and animals for food and fiber.

PROFITABILITY - the degree to which income exceeds costs.

PROGRAM - a sequence of movements, steps, or instructions which a system processes to accomplish a task.

PROTOTYPE - a pre-production model.

PSYCHOLOGICAL/EMOTIONAL NEEDS - something perceived as necessary to one's mental well-being.

QUALITY OF LIFE - characteristics which make life enjoyable such as a clean environment, choice of foods, appealing shelter, enjoyable use of leisure time, etc.

RAW MATERIAL - a basic material as it is found in nature. Raw materials are processed to improve their value and usefulness.

RENEWABILITY - the ability of resources to be replenished in a time short enough to be useful to people.

RENEWABLE RESOURCES - see resources.

RESEARCH - a systematic approach to gathering information or data.

RESOURCES - the components necessary for technology including: people, information, materials, tools and machines, energy, capital, and time. Resources that are finite will run out in time. Resources that are renewable can be replenished; *e.g.*, trees, solar energy.

RETRAINING - preparing people for new careers by teaching them new or additional skills.

ROBOTICS - a technology involving the use of programmable, multi-functional devices to perform physical tasks in response to command inputs.

SCIENTIFIC PRINCIPLES - a scientific conclusion which is generally accepted and may be stated in words or expressed by mathematical equations.

SENSOR - a subsystem used to obtain information about the output of a process of a larger system; *e.g.*, a microprocessor controlled microwave oven allows a user to program cooking temperatures of foods by using a temperature probe sensor.

SIMPLE MACHINES - devices which use mechanical advantage such as levers, pulleys, and wedges.

SOCIAL IMPACTS OF TECHNOLOGY - the impacts, both desired and undesired, expected and unexpected, of a technology upon the ways people live.

SOCIETY - a community, nation, or broad grouping of people having common traditions, institutions, collective activities, and interests.

SOLUTION - the end product of an act or the process of finding an answer to a problem; the answer to the problem.

SUBSYSTEM - a secondary, subordinate part of a larger system. The fuel system is a subsystem of the larger transportation system known as the automobile.

SUPPLY - the availability of goods or services for use or sale.

SUPPORTING COMPETENCY - a competency that a student must possess or be able to perform before being expected to satisfactorily complete a performance objective. Supporting competencies contain supportive skills, knowledge, and related information and are usually not written in specific, measurable terms.

GLOSSARY OF TERMS

SYMBIOTIC - an advantageous relationship between two or more organisms or systems.

SYNERGISTIC - a set of actions that have a greater total effect than the individual system effects.

SYNTHESIS - the combining of parts to form a whole.

SYSTEM - a regularly interacting or interdependent group of items forming a unified whole.

TECHNOLOGICAL ASSESSMENT - the act of evaluating the effectiveness and impacts of a technological system.

TECHNOLOGICAL LITERACY - the ability to use, maintain, design, construct, analyze, and assess the impact of technological systems.

TECHNOLOGICAL SYSTEM - a system through which a technical process combines resources to provide an output in reponse to an input (see closed-loop, open-loop system).

TECHNOLOGY - 1) the application of accumulated human knowledge to the transformation of resources through the use of tools for the purpose of meeting human needs and solving problems. 2) All the ways that human beings extend their capabilities to meet their wants and needs and to solve problems.

THERMOSTAT - an electro-mechanical or mechanical device which functions with changes in temperature. This device combines a sensor, a comparator, and an adjustment mechanism.

TIME - a quantity measured in years, days, hours, minutes, seconds, or parts of a second.

TOOL - a component of the human body or an instrument used to extend capabilities; *e.g.*, the human mind, human hand, a saw, thermometer, sewing needle, scalpel, shovel, calculator, microprocessor. Also includes conceptual techniques utilized in technological processes and problem solving (conceptual tools).

TRADE-OFF - the process or end result of reaching a workable compromise.

TRANSFERABLE SKILLS - broad-based skills that are common to a cluster of jobs; *e.g.*, employability skills such as dependability, promptness, basic literacy, communication skills.

TRANSPORTATION SYSTEM - the combination of tools, machines, resources, energy, and procedures used to move tangible goods, people, and information; *e.g.*, railroads, circulatory systems of plants and animals, and telephone systems.

TREND ANALYSIS - a method of forecasting the future based upon past performance.

TRIAL AND ERROR - a problem-solving process which allows for testing of various alternative solutions to meet the desired goal.

VALUES - beliefs and attitudes deemed to be worthwhile.

WANTS - things desired.

YOUTH LEADERSHIP - the concepts, programs and activities of student organizations that provide building of character, cooperation, civic pride, positive attitudes, positive values, initiative, dependability, responsibility and a host of other characteristics desirable in a leader.

MODEL TECHNOLOGY LEARNING ACTIVITIES

Technology pervades our lives, so Technology Education is necessarily a broad-based discipline. The activities which have been selected to accompany this Syllabus represent a sampling of experiences in diverse areas of technology. Because of the nature of the discipline, a model Technology Education facility which provides the context for student activity would have the capability of delivering a program of extensive breadth.

The Technology Learning Activities (TLAs) which are included with this document are intended to serve as exemplary models. Major concepts and performance objectives identified within the Syllabus are accomplished through activities outlined on the pages entitled "Procedure for this Activity." The performance objectives can be met through a wide variety of activities, and Technology Education teachers are encouraged to use the TLA format and develop additional activities.

Key elements of the Technology Learning Activity are the problem-solving approach incorporated within the activity and the link between Technology and other subjects and life experiences identified within the TLA Constants. In addition, some TLAs have an appendix containing supplementary science, math, and/or social science concepts.

INTRODUCTION TO TECHNOLOGY TECHNOLOGY LEARNING ACTIVITY

EARLY TECHNICAL DEVICES

MODULE NUMBER: T-1
NUMBER OF DAYS: 15-20

MAJOR CONCEPTS TO BE ADDRESSED

T-1A People study about technology because much of human progress has occurred as a result of technological development.

T-1B Work, job opportunities, and careers are in constant change because of the evolution of technology.

T-1C People's routines are influenced by technology.

T-1D People create and use technology as a means of satisfying basic biological, physical, and psychological needs and wants.

T-1E Information technology satisfies our need to communicate ideas and process information.

T-1F Biologically related technology seeks to satisfy our biological needs; it promotes, enhances, and supports the advancement of the improved quality of life.

T-1G Physical technologies satisfy many physical needs through construction of shelter, transportation of people and goods, and production of clothing and other necessities.

T-1H Complex technologies develop from more simple technologies, and the development is a constantly evolving process.

T-1I Technology has existed for over one million years; it is growing at a faster rate today than ever before in history.

T-1J The development of technology results in a greater and more rapid production of goods and communication of information.

OVERVIEW OF TLA

The development of technical devices helps to simplify daily work tasks and increase productivity resulting in a better way of life. Students will learn how devices have evolved in the three aspects of technology and begin to understand the impacts of these devices on society. Students will produce a device, tracing its development from simple beginnings and noting its impact on society.

EQUIPMENT AND SUPPLIES

- Suitable wood or other materials to be used to make main parts
- Dowels
- Assortment of metal fasteners
- Assortment of basic hand tools
- Sand paper
- Glue

PROCEDURE FOR THIS ACTIVITY

Days	POs*	Teacher Activity	POs*	Student Activity
1	1a 3b	Introduction to technology, and how it satisfies basic human wants and needs. Define an agriculturally, industrial, and information based society and selected enabling vocabulary.	1a 3b	Define terms in notebook.
1	2a 2c	Discussion of significant historical events in the evolution of technology. Identify some tools in each of the 3 aspects of technology. Visuals of devices for discussion (slide series, overheads, bulletin boards)	1b 2a 2b 2c	List important technological events. Place on timeline. Homework: Sketch or collect pictures of early devices. Place on timeline.
3	2c	Introduce scientific principles utilizing the lever, wedge, wheel, and axle. Relate underlying principles of tools to simple machines. Give appropriate lessons on any lab equipment used.	2c	Investigate scientific principles using legos, lab facilities, tools/machines.
1	3a 3c	Introduction of standardized parts. Discussion of how this affected technical devices. Lesson on drafting knowledge needed to produce drawing of tools.	3a 3c	Create a list of standardized parts and their effects on technology. Practice drafting skills.
1	PO3	Give examples of wants and needs in the 3 aspects of technology.	3a 3b PO3	Research technological innovations (tools, devices) to satisfy wants and needs.
1		Discussion on the materials that can be used to produce technical devices, e.g., wood, metal, plastic, and methods of selecting materials. Discussion on the shapes of various tools and parts, function, and form.	3a 3c	Describe how materials are utilized in technical devices. Choose a particular device and provide necessary drawings. If appropriate for device, problem solve ergonomic considerations.
7-10	3c	Present related lessons on machines, tools, safety, etc. as needed. Act as a knowledge base during the construction phase.	PO3 3c	Produce a device, keeping in mind safe use of tools and equipment.
1	PO2	Coordinate testing of devices. Monitor discussion on PO2. Relate to the three technologies (include tool constructed). Finish enabling vocabulary.	PO2	Exchange devices among students for testing. Homework: Define terms in notebook. Trace the history of a tool in each of the 3 technologies. (Include the tools built.) Identify daily routines influenced by technology and contribution to progress.
1	PO1	Lead a discussion on the history of the community in which they live. Provide data on U.S. employment change and relate to the three technologies. Review activity and syllabus content.	PO1	Do assignment sheet for PO1. Relate tool constructed to evolution of technology. Graph employment change. Test on Module 1.
15-20 Total Days				

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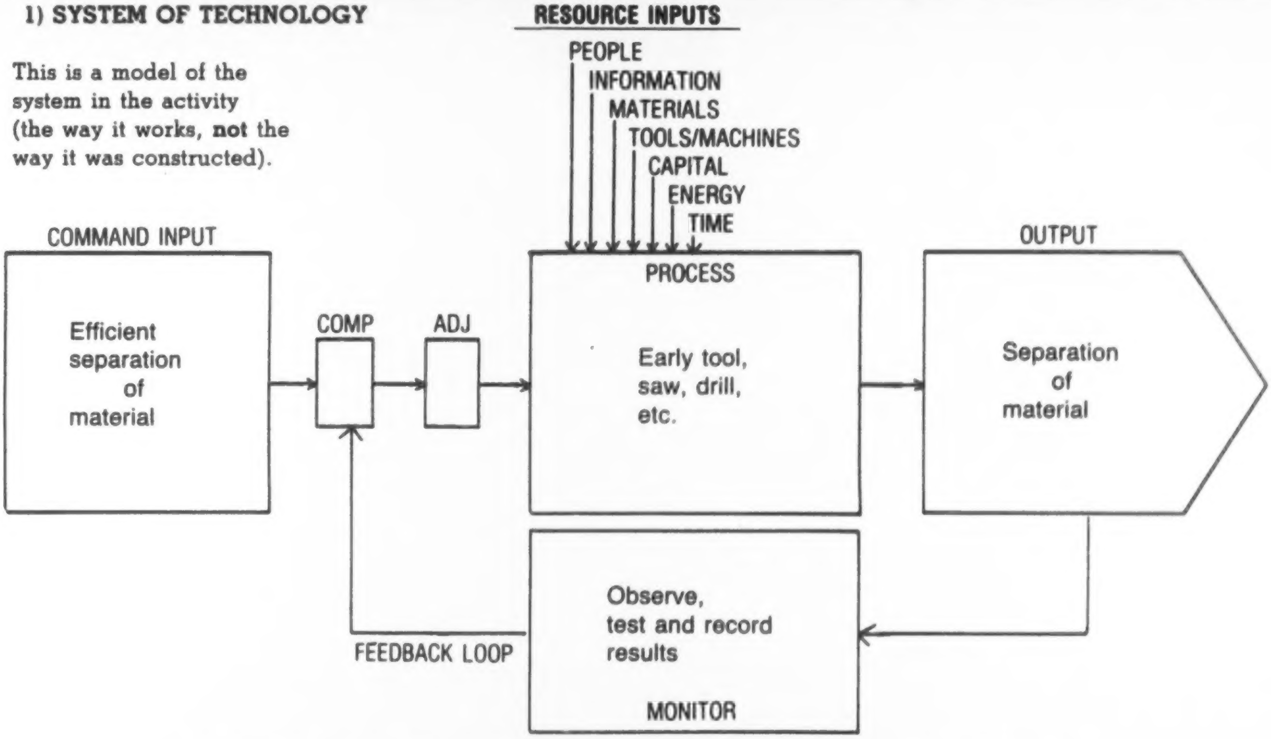
*See Syllabus for phrasing of performance objectives and supporting competencies.

CONSTANTS FOR INFUSION INTO THE TLA

1) SYSTEM OF TECHNOLOGY

This is a model of the system in the activity (the way it works, **not** the way it was constructed).


RESOURCE INPUTS
PEOPLE
INFORMATION
MATERIALS
TOOLS/MACHINES
CAPITAL
ENERGY
TIME
COMMAND INPUT
Efficient separation of material
COMP
ADJ
PROCESS
Early tool, saw, drill, etc.
OUTPUT
Separation of material
FEEDBACK LOOP
Observe, test and record results
MONITOR

IDENTIFY THE ROLE OF THE FOLLOWING RESOURCES IN THE SYSTEM ABOVE:
PEOPLE, INFORMATION, MATERIALS, TOOLS & MACHINES, CAPITAL, ENERGY, TIME

2) MATH - Addition and subtraction of whole number and fractions, diameter and circumference of circles, reading a ruler, locations for tool operations. See Math Concepts Appendix.

3) SCIENCE - Properties of materials, e.g., plasticity, hardness, toughness, strength. Classification of materials, e.g., alloys, hardwoods. Use of simple machines such as lever, inclined plane, screw, wheel and axle. See Appendix.

4) HUMAN & SOCIAL IMPACTS - Provides ease of work. Provides a higher quality of life. Group work in solving problems and decision making. Impacts on society may be positive or negative.

5) COMMUNICATION SKILLS - Vocabulary, e.g., ergonomics, alloy, plasticity. Drawings, sketches, symbols, dimension, alphabet of lines.

6) SAFETY AND HEALTH - Safe use of tools, equipment and materials while performing various production tasks.

7) PSYCHOMOTOR SKILLS - Develop eye-hand coordination and manual dexterity.

8) CAREER RELATED - Designer, engineer, tradesperson, teacher.

9) CREATIVE PROBLEM SOLVING - Opportunities for creative problem solving will be provided by this TLA including: identification and definition of a problem, goal and criteria setting, generation of alternative solutions and recognition of limitations, optimization, testing, and evaluation.

10) TRANSFER OF LEARNING - Use of tools and equipment. Standardization of parts or products: doors, windows, saw blades.

BACKGROUND REFERENCES AND RESOURCES

Historical Machines, Timetable Technology. New York: Hearst Books.

Wood Binding Handbook. London, England: Forest Products Laboratory.

Colonial Furniture Making For Everybody. New York: Van Nostrand Reinhold Co.

Popular Mechanics. July 1984

Mechanix Illustrated. July 1984.

Farmers Museum, Cooperstown, N.Y.

Old Sturbridge Village, Sturbridge, Massachusetts

State Museum, Albany, N.Y.

EVALUATION

The teacher should develop a two component evaluation system to determine if the student understands: (1) performance objectives and (2) skills, attitudes, knowledge & safety related to the specific lab activity.

(1) EVALUATION OF PERFORMANCE OBJECTIVES (Examples)

1. Give examples of how daily routines have been influenced by the three aspects of technology. PO2

2. Support in writing the shift from an agriculturally based to an industrially based to an information based society. PO1

3. Trace the history of a selected tool and describe its effect on society. PO2

4. Produce a timeline from which you can deduce the approximate historical development of 7 significant devices (include time devices). 2c

5. List some technological innovations which satisfy human wants and needs in the three technologies. 3b

6. Choose a method now commonly done by power machinery that could not be developed until supporting technology had evolved. Then ask the student to identify that technology. 2a, 2c

7. Short answer test questions could be drawn from the performance objectives and supporting competencies.

(2) EVALUATION OF SKILLS, ATTITUDES, KNOWLEDGE & SAFETY (Examples)

1. Identify parts of lab machines utilizing the following categories: support and cover, energy transmissions, and guidance and control.

2. Give a quiz on related safety, drawings, and/or materials used in the construction of the historic tool.

3. Using the tool constructed, list the changes that the tool has undergone since its early development. Describe what a modern version of the tool would look like.

4. List standardized parts that are readily available for the tool constructed.

5. After completion of tool testing, you probably noted disadvantages in the operation of the tool or device. List these disadvantages and note whether they still exist in the tool today.

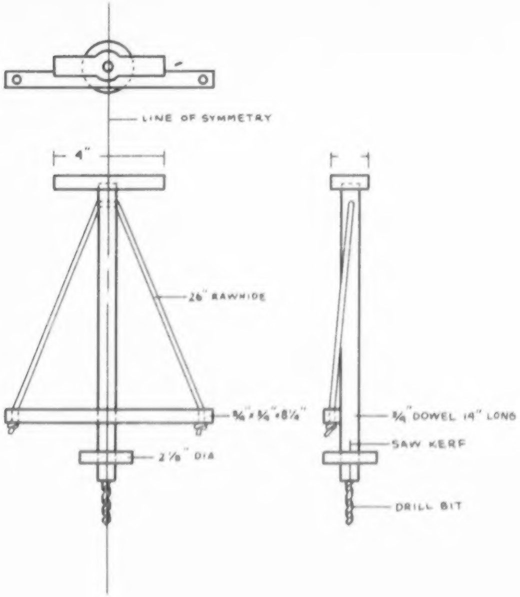
6. Select an example of lab equipment and have the student observe the machine in operation. List examples of simple machine principles incorporated in its construction and operation.

APPENDIX: MATH CONCEPTS

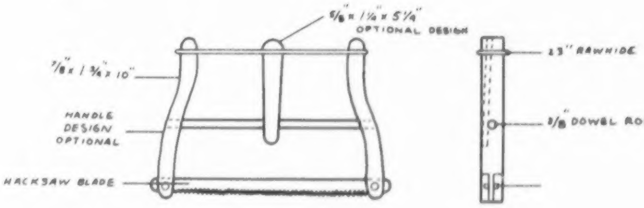
1. In looking at tools, look for **symmetry** (line of symmetry). Discuss **congruent** (same size and shape) parts for standardization.
2. Use vocabulary: vertical; horizontal; perpendicular (meet at right or 90 degree angles).
3. **Measurement:** Adding, subtracting fractional numbers (customary measure system), decimal numbers in metric system.
4. **Reading ruler.**
5. Calculate circumference of circle given diameter. Find radius when given circumference.

APPENDIX: PUMP DRILL & SAW

PUMP DRILL


LINE OF SYMMETRY
4"
26" RAWHIDE
3/4" x 3/4" x 8 1/4"
2 7/8" DIA
3/4" DOWEL 14" LONG
SAW KERF
DRILL BIT

SAW


5/8" x 1 1/4" x 5 1/4"
OPTIONAL DESIGN
7/8" x 1 3/4" x 10"
HANDLE DESIGN OPTIONAL
HACKSAW BLADE
23" RAWHIDE
3/8" DOWEL ROD 9"

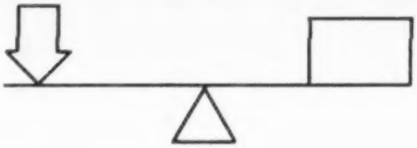
APPENDIX: INTRODUCTION TO SIMPLE MACHINES

1. **Force** is a push or pull on an object.
2. **Distance** is the space over which an object has moved.
3. **Work** is calculated by multiplying the force applied to an object by the distance the object has moved.
4. Simple machines usually decrease the force necessary to move an object by requiring motion over varying distances.
5. One example of a simple machine is the lever, of which there are three types.
6. Levers all have three basic components acting together:
   a. Fulcrum - Balance point for the lever - △
   b. Resistance - object that work will be done on - ▭
   c. Force - push or pull exerted on the lever - ⇧

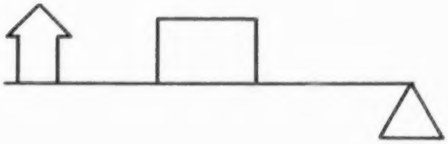
Appendix: Introduction to Simple Machines (continued)

7. The three types of levers and what they look like:

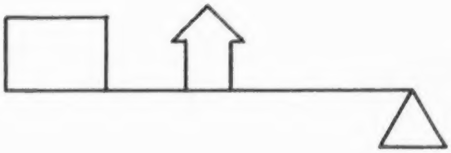
a. 1st class lever -



b. 2nd class lever -



c. 3rd class lever -



INTRODUCTION TO TECHNOLOGY TECHNOLOGY LEARNING ACTIVITY

TIME: THE FOURTH DIMENSION

MODULE NUMBER: T-1
NUMBER OF DAYS: 15-20

MAJOR CONCEPTS TO BE ADDRESSED

T-1A People study about technology because much of human progress has occurred as a result of technological development.

T-1B Work, job opportunities, and careers are in constant change because of the evolution of technology.

T-1C People's routines are influenced by technology.

T-1D People create and use technology as a means of satisfying basic biological, physical, and psychological needs and wants.

T-1E Information technology satisfies our need to communicate ideas and process information.

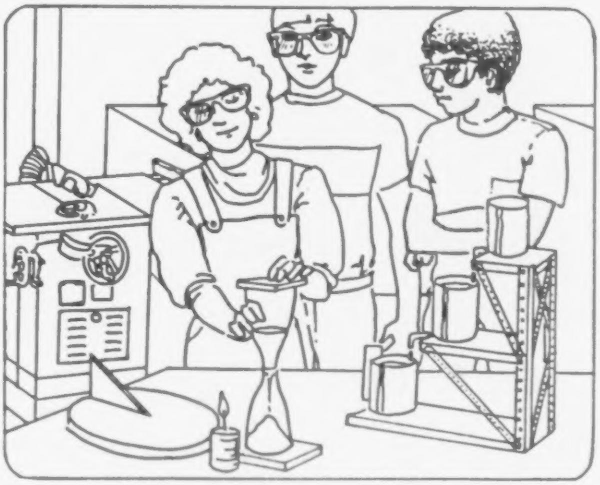
T-1F Biologically related technology seeks to satisfy our biological needs; it promotes, enhances, and supports the advancement of the improved quality of life.

T-1G Physical technologies satisfy many physical needs through construction of shelter, transportation of people and goods, and production of clothing and other necessities.

T-1H Complex technologies develop from more simple technologies, and the development is a constantly evolving process.

T-1I Technology has existed for over one million years; it is growing at a faster rate today than ever before in history.

T-1J The development of technology results in a greater and more rapid production of goods and communication of information.



OVERVIEW OF TLA

In this activity students will examine samples of timekeeping devices that reflect the early evolution of timepieces. Through the construction of handcrafted devices such as sand, water, and candle clocks and the sundial, students will explore the impacts of primitive timekeeping technology. Through discussion/demonstration of subsequent technologies, students will identify the human needs and technological advances that led to modern clocks.

EQUIPMENT AND SUPPLIES

- Sundial: almost any available material
- Candle Clock: candles of varying lengths and diameters
- Water Clock: 3 one-lb. coffee cans, 2 single aquarium valves, 3' aquarium tubing for valves, cork float, 1/16 metal tubing, fine stiff wire for indicator, wood, glue, etc. for frame
- Sand Clock: 2 one-liter bottles, fine sand, asstd. metal washers, wood or other material for stand
- General lab supplies and equipment

PROCEDURE FOR THIS ACTIVITY

Days	POs*	Teacher Activity	POs*	Student Activity
1	1a 3b	Discuss the three technologies. Define an agricultural, industrial, and information based society. Differentiate between wants and needs. See Syllabus.	1a, 1b 1c, 2a 2b, 2c 3b	Write the definitions in notebook. Utilize adults, relatives, community resources etc., to identify historical tools. Arrange examples on a timeline.
1	2a	Discuss tools, devices, and methods involving the three technologies (include time-keeping devices).	2a 2c	Assign readings.
1	PO3	Give examples of wants and needs in the 3 aspects of technology. Monitor discussion on PO3. Introduce brainstorming. Introduce early timekeeping devices, e.g., sundial, water, sand, and candle clock. (If possible use media such as Connection film; - see Reference under Burke.) Instruct students on Log Assignment.	3a PO3	Log Assignment: Keep a two-day record of significant influences that timekeeping devices, or the lack of them, had on you. Research examples of technological innovations in the 3 aspects of technology.
1	PO3	Give students the problem of constructing one of the timekeeping devices.	3a	Write a flowchart or describe the processes involved in constructing the timekeeping device. Evaluate both modern and historical timekeeping devices to make a comparison chart (matrix) of their efficiency.
9-14	3c	Explain proper and safe methods for using tools, machines, and processes involved in constructing the timepiece. Act as a knowledge base in the construction and feedback of the timekeeping devices.	3c PO3	Construct timekeeping devices, either individually or in groups.
			3a 3c	Activate timekeeping devices and make modifications in construction if needed (system feedback).
1	PO2	Monitor discussion on PO2. Relate to the three technologies. (Include timekeeping devices.) Finish defining module vocabulary.	2b PO2	Assignment - Trace the history of a tool in each of the three technologies (include timekeeping devices). Identify daily routines influenced by technology and contribution to progress. Define module vocabulary in notebook.
1	PO1	Lead a discussion on the history of the community in which they live. Provide data on U.S. employment change and relate to the three technologies. (Include timekeeping devices.)	PO1	Do homework assignment sheet: graph percentage of the work force employed in agriculture, industry, and information technology over time.
		Review activity and syllabus content.		Test on Module 1.
15-20 Total Days				

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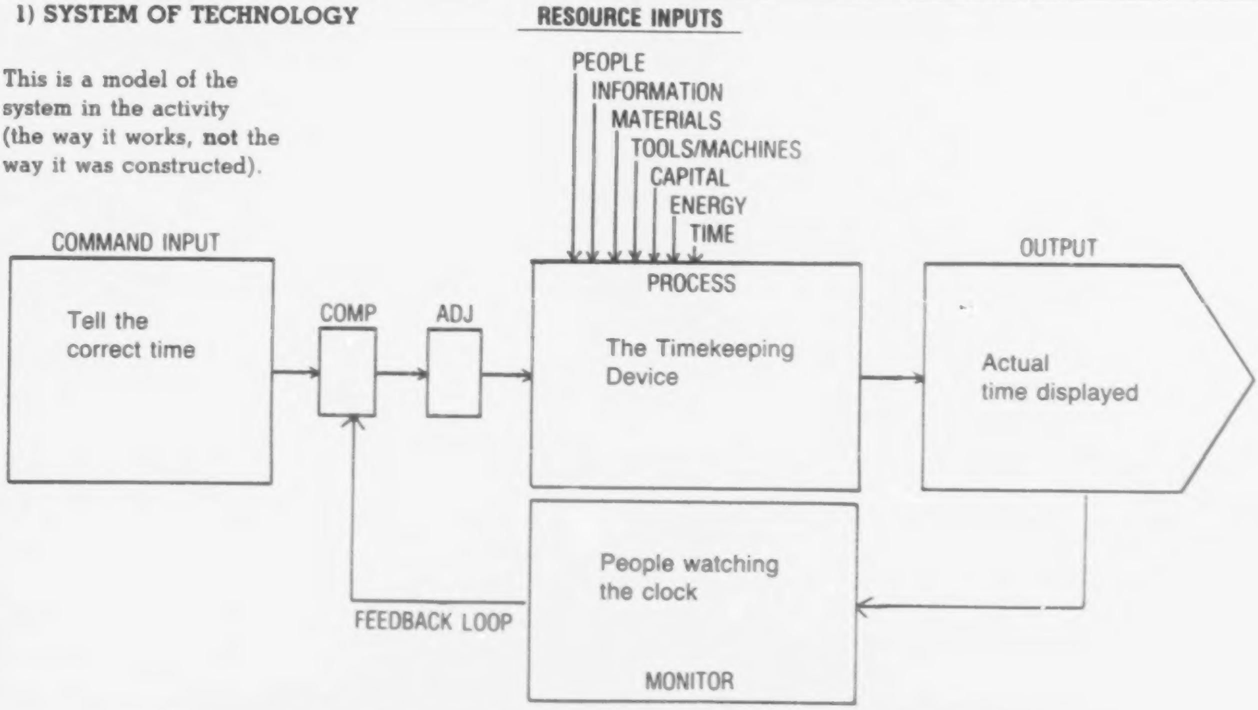
*See Syllabus for phrasing of performance objectives and supporting competencies.

CONSTANTS FOR INFUSION INTO THE TLA

1) SYSTEM OF TECHNOLOGY

This is a model of the system in the activity (the way it works, **not** the way it was constructed).


RESOURCE INPUTS
PEOPLE
INFORMATION
MATERIALS
TOOLS/MACHINES
CAPITAL
ENERGY
TIME
COMMAND INPUT
Tell the correct time
COMP
ADJ
PROCESS
The Timekeeping Device
OUTPUT
Actual time displayed
People watching the clock
FEEDBACK LOOP
MONITOR

IDENTIFY THE ROLE OF THE FOLLOWING RESOURCES IN THE SYSTEM ABOVE:
PEOPLE. INFORMATION. MATERIALS. TOOLS & MACHINES. CAPITAL. ENERGY. TIME.

2) MATH - Calibration, multiplication of figures; volume calculations, averages, periods, ratios, frequency.

3) SCIENCE - Surface tension of water, pressure necessary to overcome surface tension, wetting agents, volume of water, weight of water, weight of sand, evaporation, freezing, composition of materials, chemistry of materials. The stars provided navigational information to sailors for centuries.

4) HUMAN & SOCIAL IMPACTS - Humans' routines are influenced by time cycles provided by the sun, moon, and stars. The sun influences rising time, working times, and bedtimes, and controls agricultural cycles.

The moon influences tides; some feel that there are psychological effects due to the moon's cycle. Some cultures (e.g., Chinese) depend upon a lunar calendar.

The development of clocks was spurred by the clergy who needed to pray at specified times. Water clocks evolved as a direct outgrowth at this need. The development of gears for clocks and toys led to increased accuracy in production.

Calendars have existed for thousands of years, in a variety of forms (Mayan, Chinese, Hebrew, Egyptian, Roman). Time schedules became standard for advertising. Railroads and airplanes sold their services to the public based upon their ability to keep accurate schedules. Time and motion studies increased industrial production and created labor/management friction.

5) COMMUNICATION SKILLS - Digital atomic clock communicating to people.

6) SAFETY AND HEALTH - Fire, cements, sharp metal, aerosol propellants, solvents. Normal laboratory tools and equipment.

7) PSYCHOMOTOR SKILLS - Fine tool skills, measurement of time.

8) CAREER RELATED - Agriculture, mining, manufacturing, construction, transportation, economics, energy, humans, astrology, horology, astronomy, science, and engineering.

9) CREATIVE PROBLEM SOLVING - Opportunities for creative problem solving will be provided by this TLA including: identification and definition of a problem, goal and criteria setting, generation of alternative solutions and recognition of limitations, optimization, testing, and evaluation.

10) TRANSFER OF LEARNING - Productivity; surface tension as applied to wetting agent, flow of water through fire department hoses, dishwasher detergents, shampoo, photography; time and motion studies; humidity; Venturi welding torch; hydro-electric plants; spring and fall equinox; gravity

BACKGROUND REFERENCES AND RESOURCES

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Singer, Charles (Ed.). *A History of Technology, Vol. II. The Mediterranean Civilization and the Middle Ages*. London, England: Oxford University Press, 1957.

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The Bible

The Smithsonian Museum, Washington, D.C.

The Science Museum, London, England.

The Clock Museum (Seth Thomas), Connecticut.

EVALUATION

The teacher should develop a two component evaluation system to determine if the student understands: (1) performance objectives and (2) skills, attitudes, knowledge & safety related to the specific lab activity.

(1) EVALUATION OF PERFORMANCE OBJECTIVES (Examples)

1. Give examples of how daily routines have been influenced in the three technologies. PO2

2. Support in writing the reasons for the shift from an agricultural based to an industrially based to an information based society. PO1

3. Trace the history of a selected tool and describe its effect on society. PO2

4. Produce a timeline from which you can deduce the approximate historical development of 7 significant devices. (Include time devices.) 2c

5. List some technological innovations which satisfy human wants and needs in the three technologies. 3b

6. Choose a task now commonly done by power machinery that could not be accomplished until supporting technology had evolved. Then ask the student to identify that technology. 2a, 2c

7. Short answer test questions could be drawn from the performance objectives and supporting competencies.

(2) EVALUATION OF SKILLS, ATTITUDES, KNOWLEDGE & SAFETY (Examples)

1. The sand clock has terrarium sand. What other material could be substituted that would probably improve the sand clock?

2. Compare the accuracy of the 4 timekeeping devices we have used as examples. Rank them in the order of probable exactness over a period of 24 hours. How much accuracy could be expected of the best clock or timekeeping device? (Accuracy should be stated in terms of seconds, minutes, and hours.)

3. You have seen a model of the water clock. Develop 3 additional methods of construction for a water clock that would improve upon this original design.

4. Evaluate the water clock that we have used as a model from these points of departure:
   - A. The known concepts of science today. (Use 2 or 3 ideas.)
   - B. The use of water as a liquid in the water clock.
   - C. The volume of water that is necessary to make the device easier to construct.
   - D. If you take away the top reservoir (blue) on the present model, what changes would have to be made in the calibration of the clock? What design changes need to be considered for the clock if it no longer has the blue reservoir?

5. How would the use of some time devices be limited by the climate?

APPENDIX:
SCIENCE & MATH CONCEPTS & OTHER RELATED MATERIAL

Science

1. Time is a continuously flowing quantity.
2. People break time into discrete "bundles" for various purposes.
3. Measuring time is an important part of scientific research.
4. For many scientific purposes, time measurements must be extremely accurate.
5. Historically, many devices were used to measure time - e.g., sundial, water clocks.
6. Sundials require a knowledge of the sun's motions through the sky for each part of the year.
7. Modern scientists use movements within atoms of various materials to measure time accurately.
8. Many living things contain biological clocks which direct processes of life.

Math

Sundial: Division of a circle in 15 sectors using a protractor

Candles and Coffee Cans: Measurement of volume in a cm^3 using formula, $V = \underbrace{\pi r^2}_{\text{Area}} \bullet h$;

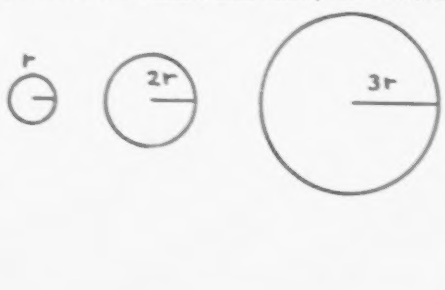
Discuss how volume changes as radius changes.

Sand Clock: Measure volume of sand in cm^3 or mm^3, weight of sand in grams.

Measurement of elapsed times using a stopwatch or by subtracting beginning from ending time (which are given in minutes and seconds from standard or digital watch). Students have difficulty with this.

Calibration: measurement using metric or customary measures, dividing a measure into an equal number of parts.

Rates figured in terms of cm^3/min., mm^3/sec., etc. Averages of trials to get a better measure.



When the radius is doubled, the area of the circle (of the water hole) is **four** times as large; when radius is tripled, the area is **nine** times as big.

The radius and the height of the cylinder affect the volume.

APPENDIX: CONSTRUCTION OF DEVICES

In order to encourage the maximum creativity, choice of materials for making the various devices should be determined by local availability and by the design.

Sundial - may be made of wood, plastic, metal, ceramic, etc. Construction and layout details can be found in any public library. Attached are some possibilities.

Candle Clock - use a variety of candle lengths and diameters. Experiment and calibrate.

Sand Clock - the author used 2 one liter soda bottles, cut down and joined together. The bases may be as illustrated on the front page and made of any material. You may make a more elaborate framework if you wish. Experiment with media other than sand. The space between the vessels may be made of washers or a solid piece of metal with a hole drilled in it.

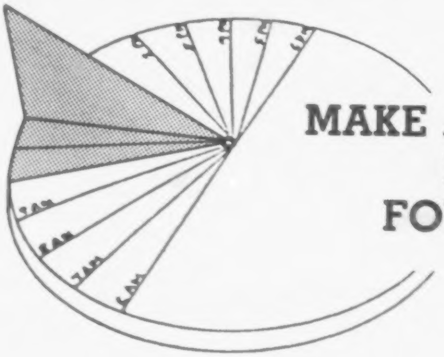
Water Clock - the water clock is the most complex of the four devices. The design illustrated has purposely been left without calibraton to encourage creativity. The author used coffee cans but you may use whatever containment vessel you deem appropriate. One means of marking the rising height of the water level is illustrated. Simpler and more complex methods would work as well.

In the method shown (See Appendix: Water Clock) the reservoir tank flows into the primary tank at a faster rate than the primary flows into the measuring tank. This is to maintain constant pressure. Overflow is taken care of as indicated. The cork float has a hole in its center by which it rides over a guide rod. A wire, supported by means of a fine guide tube, is fastened to the float on one end. Then it is extended over the top of the tank and down onto a scale which is fastened to the exterior of the tank. Other means may effectively be employed.

APPENDIX: VOCABULARY

Astrolab
Astrology
Astronomy
Atomic Clock
Calendar
Celestial Pole
Chronometer
Crystal
Daylight Saving Time
Dimension
Escapement
Equinox
Evaporation
Gnomon (NO-mum)
Greenwich Mean Time
Gregorian
Hairspring
Horizontal
Horology
Hourglass
Impulse
Julian
Latitude
Longitude
Mainspring
Meridian
Microsecond (10^{-6}s or uS)
Military Time
Millisecond (10^{-3}s or mS)
Molecules
Nanosecond (10^{-9}s or nS)
Olympiad
Oscillation
Pendulum
Picosecond (10^{-12}s or pS)
Standards
Sundial
Synthetic
Universal Time
Vibration

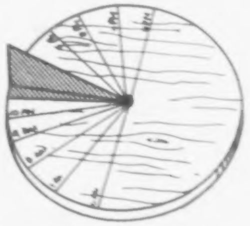
APPENDIX: SUNDIAL



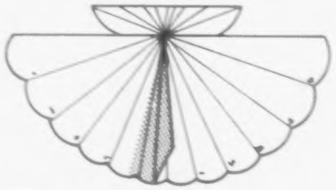
MAKE A SUNDIAL IN ONE OF FOUR STYLES

Kenneth S. Hulme

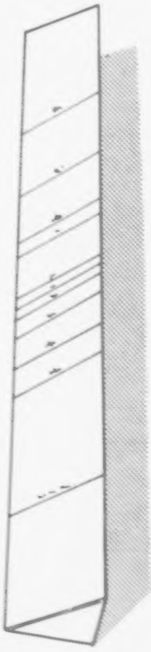
Designing and making sundials, called "dialing," is an ancient craft that can be practiced with modern tools and materials. If you lay out and assemble the dials correctly, these "solar clocks" can be almost as accurate as an electric clock.



Horizontal sundial is "traditional," has gnomon pointing generally north, then gnomon shadow is set to correct time.

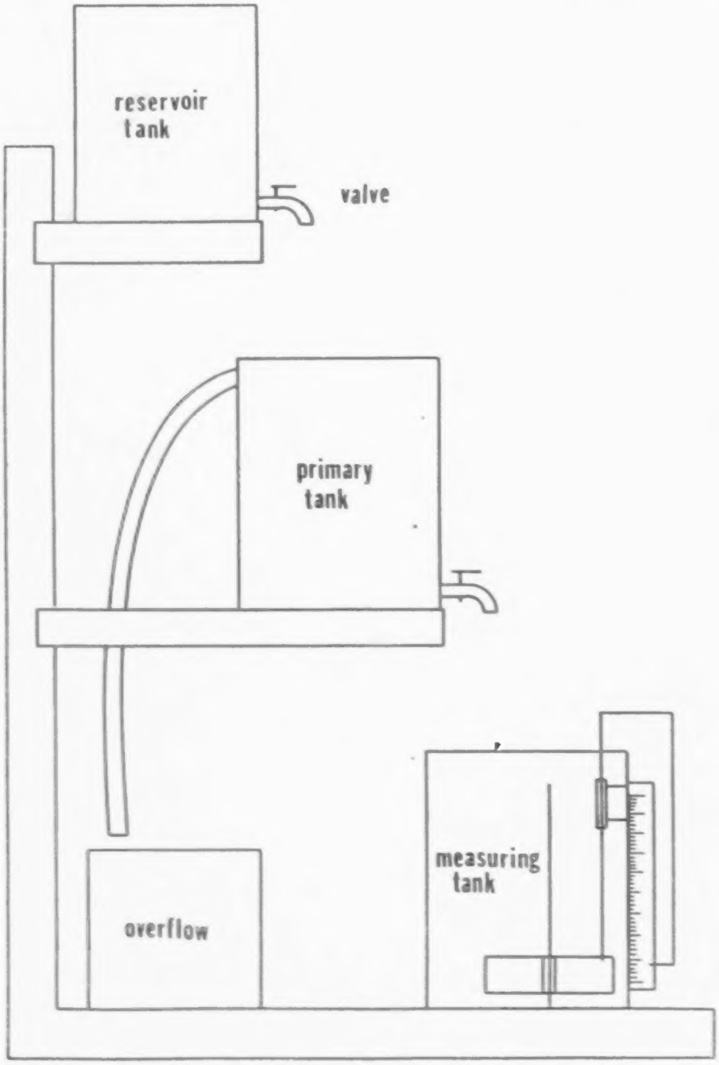


Vertical sundial is faced due south, and should be shimmed so that it does if wall is not truly facing south.

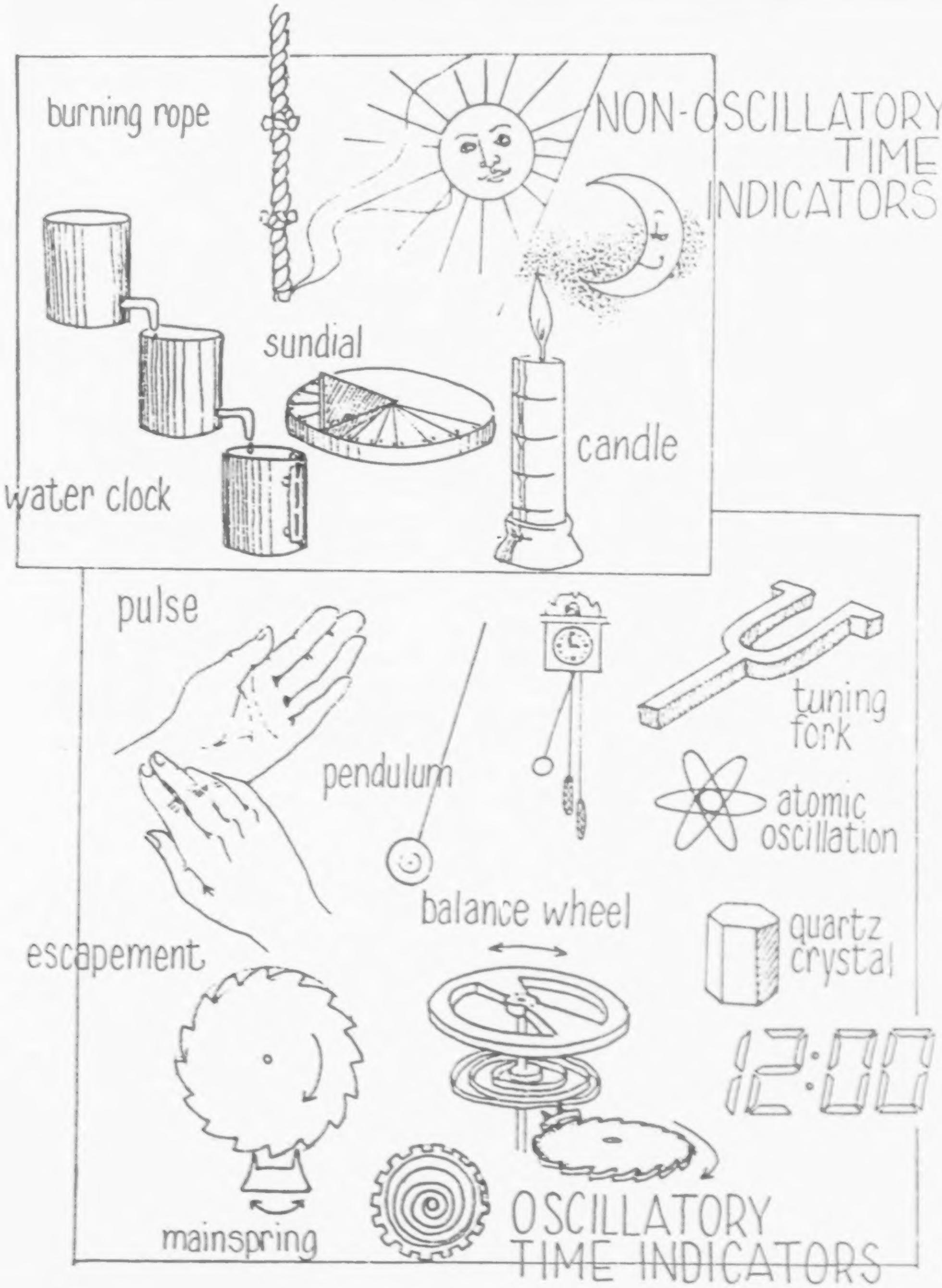


Polar sundial is placed so upper edge of face is to the north. Adjust position until it reads correctly.

APPENDIX: WATER CLOCK


reservoir tank
valve
primary tank
measuring tank
overflow

APPENDIX: TIME INDICATORS


burning rope
NON-OSCILLATORY TIME INDICATORS
sundial
candle
water clock
pulse
tuning fork
pendulum
atomic oscillation
balance wheel
quartz crystal
escapement
12:00
mainspring
OSCILLATORY TIME INDICATORS

INTRODUCTION TO TECHNOLOGY TECHNOLOGY LEARNING ACTIVITY

LOGO DESIGN AND PRODUCTION

MODULE NUMBER: T-2
NUMBER OF DAYS: 15-20

MAJOR CONCEPTS TO BE ADDRESSED

T-2A Every technological development is dependent upon the utilization of seven resources: people, information, tools and machines, materials, energy, time, and capital.

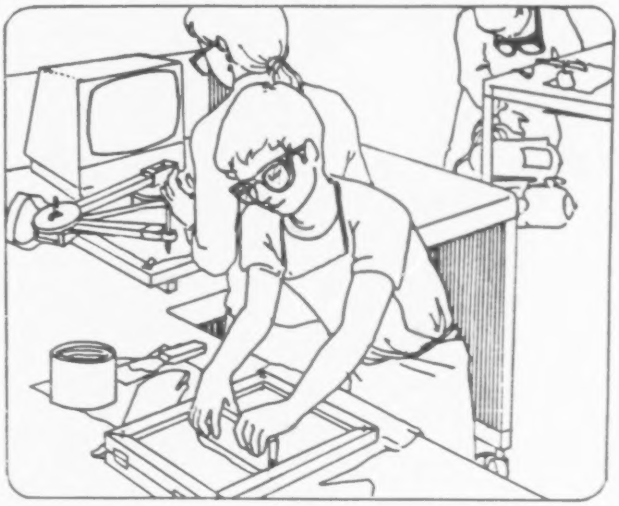
T-2B Solutions to technological problems require the development of skills in using all seven resources.

T-2C The development and use of technology are influenced by the culture and by the resources available to that society.

T-2D Global resources are finite, requiring discretion in their use and ultimately the identification of alternatives.

OVERVIEW OF TLA

This activity is designed to allow the students to realize that every technological development is dependent upon the utilization of seven identified resources. In conducting this activity the students will note that some resources are finite, requiring discretion in their use, and that sometimes alternative resources need to be developed or identified. In completing this TLA, students will categorize resources as they are found in the experience of daily life. Each student will design a logo which will incorporate the seven resources of technology. Individual designs will be reproduced as buttons or on student provided T-shirts. Those judged to be exceptional may be mass produced.



EQUIPMENT AND SUPPLIES

- Materials to construct frame: nails, screws, screen material; photo-sensitive emulsion, light source, ink, squeegee, heat lamp; hammer, screwdriver, staple gun, cleaning supplies
- 2¾" button parts, button-making machine, method to reproduce design
- Offset lithography supplies and printing equipment

PROCEDURE FOR THIS ACTIVITY

Days	POs*	Teacher Activity	POs*	Student Activity
1	1a	Introduce the term "resource." Explain that there are 7 resources that are needed by technology. Gives some examples for each of the 7 resources.		

LOGO DESIGN AND PRODUCTION

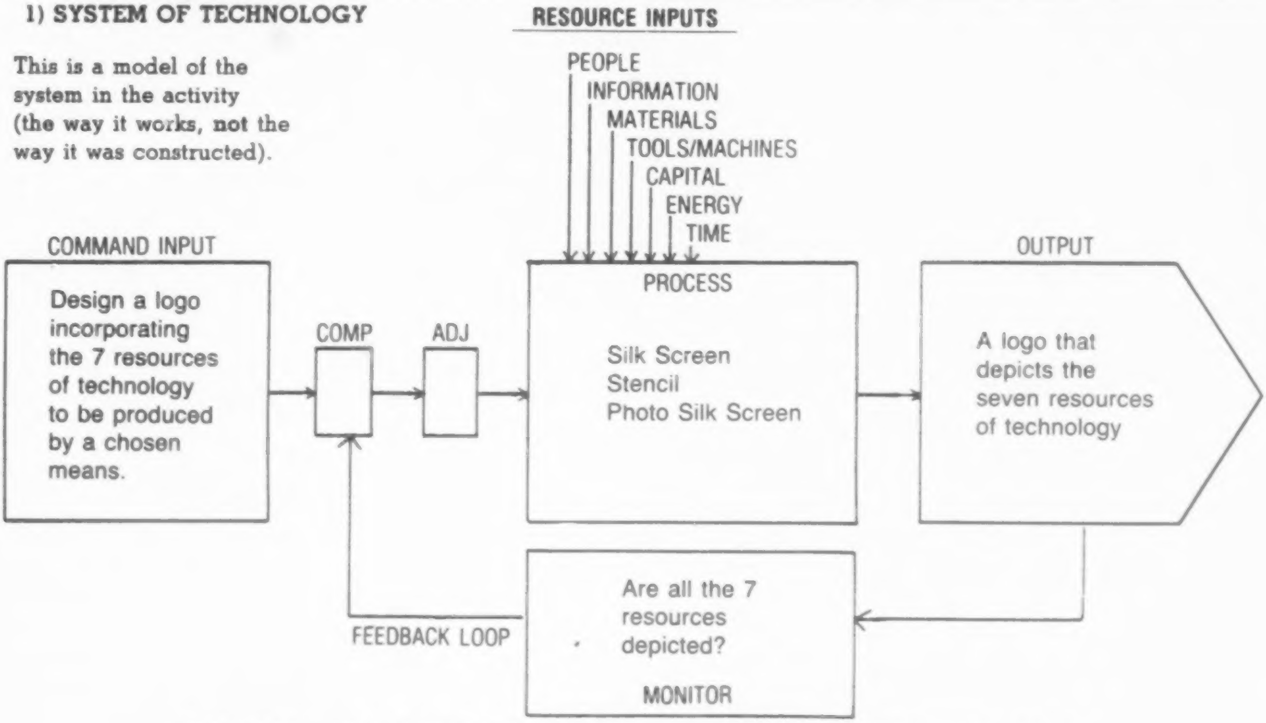
Time Days	POs*	Teacher Activity	POs*	Student Activity
	1b	Place various examples of the 7 resources of technology in front of the lab.	1a 1b	Write the examples of the 7 resources of technology in the appropriate categories in notebook.
1	1a	Introduce and explain the process of brainstorming. A separate brainstorming session will be conducted for each of the 7 "resources of technology."	1a 1b	Brainstorm as many examples of technological resources as possible and place them in the appropriate categories in notebook.
1	1a 1b	Introduce the concept of a logo. Discuss the role of symbols in communication. Use various examples: sports teams, international symbols. Show examples of symbols. Task: design a logo incorporating the 7 resources for technology to be reproduced on a technology notebook, button, or T-shirt.	1a 1b	Explain what symbols mean. For homework, design symbols that depict the 7 resources of technology. Using these symbols, design three variations of the logo.
1	2a	Instruct students to critique each others' work and then design a final product as homework. Discuss social, environmental, and economic impacts of the technological resources that are being incorporated into the design.	1a 1a	Create a tentative design display which will be presented to the class at the end of the period. Using feedback from the class, make a final logo design for homework.
2-3	1c 2a 2b 2c PO1 PO2	Demonstrate lab equipment and machines that will be used for making logo into a silkscreen, button, or printed item. Discuss historical development of the technology being demonstrated.	2b	For homework identify what resources have been used for each machine or operation. Explain how the technological development of that machine or operation is dependent on the 7 resources.
8-11	1c 2c	Allow students to reproduce their own designs or synthesize one design to be reproduced by the entire class. Quantities will depend on the end use and method of production. Monitor laboratory activity.	1c 2a 2c PO1 PO2	Use materials, tools, instruments, equipment, and procedures safely in the laboratory to process or convert resources into the final logo product.
1-2	3a 3b	Distinguish what a renewable and non-renewable finite resource is. Give examples of products which utilize non-renewable resources and suggest appropriate technological alternatives.	3a 3a 3b 3c	Identify which resources used in the logo design are renewable and which are non-renewable. For homework research and write a report on the appropriate technological alternatives that could be used in place of non-renewable resource that was used in the logo product.
	PO3	Give examples of nations with differing cultural conditions and resources.	PO3	Brainstorm to find a list of alternatives for technological methods appropriate for various cultures. Homework: refine and modify list. Place in notebook.
		Review Module 2.		Test on Module 2.
15-20 Total Days				

*See Syllabus for phrasing of performance objectives and supporting competencies.

CONSTANTS FOR INFUSION INTO THE TLA

1) SYSTEM OF TECHNOLOGY

This is a model of the system in the activity (the way it works, not the way it was constructed).


RESOURCE INPUTS
PEOPLE
INFORMATION
MATERIALS
TOOLS/MACHINES
CAPITAL
ENERGY
TIME
COMMAND INPUT
Design a logo incorporating the 7 resources of technology to be produced by a chosen means.
COMP
ADJ
PROCESS
Silk Screen
Stencil
Photo Silk Screen
OUTPUT
A logo that depicts the seven resources of technology
FEEDBACK LOOP
Are all the 7 resources depicted?
MONITOR

IDENTIFY THE ROLE OF THE FOLLOWING RESOURCES IN THE SYSTEM ABOVE:
PEOPLE, INFORMATION, MATERIALS, TOOLS & MACHINES, CAPITAL, ENERGY, TIME

2) MATH - Large scale design - proportions - reduced scales. Photo-reduction and Xerox process camera. The use of architect's and machinist's scales. Pantograph.

3) SCIENCE - Chemistry of offset lithography - water and oil density. Photography - acid and base chemicals, photosensitivity of materials, reflectance of light.

4) HUMAN & SOCIAL IMPACTS - Individual problem solving and decision making. Students will become aware of the wide variety of technological resources that are within the seven categories. Social, economic, and environmental impacts of those resources may be discussed and represented within the logo design.

5) COMMUNICATION SKILLS - Ability to communicate a complex set of concepts through symbols. Based on a familiarity with international symbols, students may develop symbolic representations of the seven resources of technology.

6) SAFETY AND HEALTH - Students will demonstrate the safe use of tools, materials, and machines in the process camera, silk screen printing, or button making machine. Shop safety procedures will be utilized in activities and production periods.

7) PSYCHOMOTOR SKILLS - Sketching. Hand layout tools: small psychomotor skills. Hand-eye coordination.

8) CAREER RELATED - Technical illustration artist; offset lithographer and related occupations; photographer; production and control manager; small business manager.

9) CREATIVE PROBLEM SOLVING - Opportunities for creative problem solving will be provided by this TLA including: identification and definition of a problem, goal and criteria setting, generation of alternative solutions and recognition of limitations, optimization, testing, and evaluation.

10) TRANSFER OF LEARNING - Communication of ideas through symbols between individuals speaking different languages. Utilization of brainstorming technique to develop an individual's occupation/career alternatives.

BACKGROUND REFERENCES AND RESOURCES

The American Institute of Graphic Arts. *Symbol Signs*. Springfield Va. National Technical Information Services, 1974.

Book of international symbols.

McCrory, D.L. and Maughan, G.R. *Resources in Technology*. Worcester, MA: Davis Publications, Inc.

EVALUATION

The teacher should develop a two component evaluation system to determine if the student understands: (1) performance objectives and (2) skills, attitudes, knowledge & safety related to the specific lab activity.

(1) EVALUATION OF PERFORMANCE OBJECTIVES (Examples)

1. All the knowledge that has been discovered and learned by people known as the ______________ resource for technology. (1a)

2. Iron ore is an example of which resource for technology?

a) information, b) tools and machines, c) materials, d) capital. (1a)

3. Electricity is an example of which resource for technology?

a) people, b) energy, c) information, d) capital. (1a)

4. Which of the following is an example of a renewable resource?

a) oil, b) iron ore, c) electricity, d) paper. (3a)

5. How did primitive societies communicate ideas? How is the development and use of technology influenced by the culture of a society and the resources available to it?

(2) EVALUATION OF SKILLS, ATTITUDES, KNOWLEDGE & SAFETY (Examples)

1. There are various graphic arts reproduction techniques The technique in which an image is produced through the use of a stencil is called:

a) offset lithography, b) xerography, c) screen printing, d) press type.

2. A graphic arts technique which involves printing from a flat surface is:

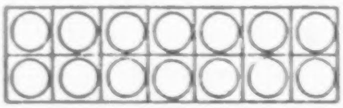
a) offset lithography, b) xerography, c) screen printing d) press type.

3. List the safety precautions that should be observed when either adhering or removing a lacquer base stencil on the screen.

APPENDIX: MATH AND SCIENCE CONCEPTS AND OTHER RELATED MATERIALS

Ratio/proportion is used in reducing or enlarging a design. Doubling length and width of a figure increases **area four times.**

Area: Consider how many buttons of a diameter of 2¾" each can be cut from a certain size sheet of material? (Figure number of squares 2¾" on a side.)



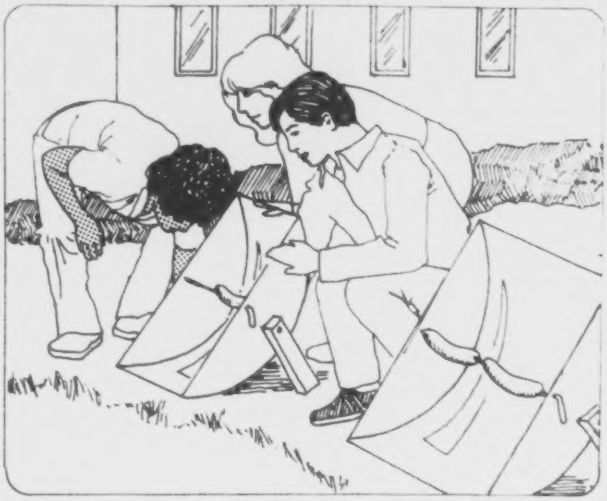
APPENDIX: MATH AND SCIENCE CONCEPTS (Continued)

Design: Students consider the basic **geometric shapes** that could be used for a logo - circles, polygons (triangles, rectangles, squares, trapezoids ⏢ , parallelograms ▱ , pentagons, hexagons, octagons, etc.). **Regular** polygons (those with all sides and angles **congruent**) vs. irregular shapes.

Alternative Production Methods: The production of a logo is not necessarily limited to graphic arts or button making processes. Logos that depict the seven resources of technology could also be produced by making a wind chime out of ceramic materials; a pattern made in wood and then cast by foundry processes into a trivet; or through the utilization and application of tools and materials in plastics.

INTRODUCTION TO TECHNOLOGY
TECHNOLOGY LEARNING ACTIVITY

USING SOLAR ENERGY TO COOK FOOD



MODULE NUMBER: T-2
NUMBER OF DAYS: 22-25

MAJOR CONCEPTS TO BE ADDRESSED

T-2A Every technological development is dependent upon the utilization of seven resources: people, information, tools and machines, materials, energy, time, and capital.

T-2B Solutions to technological problems require the development of skills in using all seven resources.

T-2C The development and use of technology is influenced by the culture and by the resources available to that society.

T-2D Global resources are finite, requiring discretion in their use and ultimately the identification of alternatives.

OVERVIEW OF TLA

Technological developments are dependent upon the resources of technology that are available. These resources are defined as materials, people, time, energy, tools and machines, information, and capital. In this activity the students will investigate utilization of these resources, and their influence on society. The activity will include material testing, selecting the correct resources, and processing them to make a solar food cooker.

EQUIPMENT AND SUPPLIES

- Construction materials - wood, metal, plastic
- Reflective material - tinplate, mylar
- Fasteners - screws, bolts, etc.
- Teacher made material testing devices
- Sample materials to test

PROCEDURE FOR THIS ACTIVITY

Days	POs*	Teacher Activity	POs*	Student Activity
1		Introduce the resources of technology as materials, capital, people, information, time, tools and machines, and energy.	1a 1b	Record information. Participate in discussion. List example of other forms that resources may be found in. Record in notebook.
	1a	List examples of what form these resources may be found in: example energy—light, sound materials—metals, ceramics people—consumer, worker		

USING SOLAR ENERGY TO COOK FOOD

Days	POs*	Teacher Activity	POs*	Student Activity
	2b	Discuss the dependency of all technology on these resources.	2b	Participate in discussion on the dependency of technology on these resources.
2-3		Discuss selecting the correct form of resource for technological use. Discuss material properties for the purpose of selecting the correct material for use.		Participate in discussion.
	1c	Set up simple test devices for students to test various properties.	1c	Go through a series of tests for material properties (hardness, reflection conductivity, etc.)
	1b PO1	Show students how to record their findings and use the information to select materials best for a specific need or use.	1b 1b PO1	Record information on data sheets or computer. Based on test results, select those materials with the best properties and tell how the material might be used.
1		Introduce concept of processing resources and changing them into different forms. Introduce activity of designing and building a solar powered food cooker. Determine which resources will be used.		Participate in discussion. With the aid of teacher, set limits and criteria for solar food cooker. Record date in notebook.
			2b	With teacher's help, fill in the following: • materials ____________ • capital ____________ • people ____________ • information ____________ • tools ____________ • time ____________ • energy ____________
12-15	2a 2c	Begin a series of demonstrations on processing and converting these resources into required forms. This would include: materials — separating, adding, contour forming, internal changes energy — light to heat information — modeling, drawing	2a 2c PO2	As a class, come up with a design based on information about solar energy, etc. Make sketches and drawings. Observe lessons on safe use of tools and materials used in the converting process. Begin construction. Complete construction.
			1b	Test and evaluate solar food cooker.
1	PO2	Lead discussion on possible changes in resource selection that would improve results of food processor.	1b PO2	Discuss results of test and evaluation of processor. Recommend changes in resources to improve results of food processor.
1	3a	Define resources as being renewable and nonrenewable. Give examples of renewable and finite resources.	3a	Record information and participate in discussion. Give examples of finite and renewable resources found in this country.

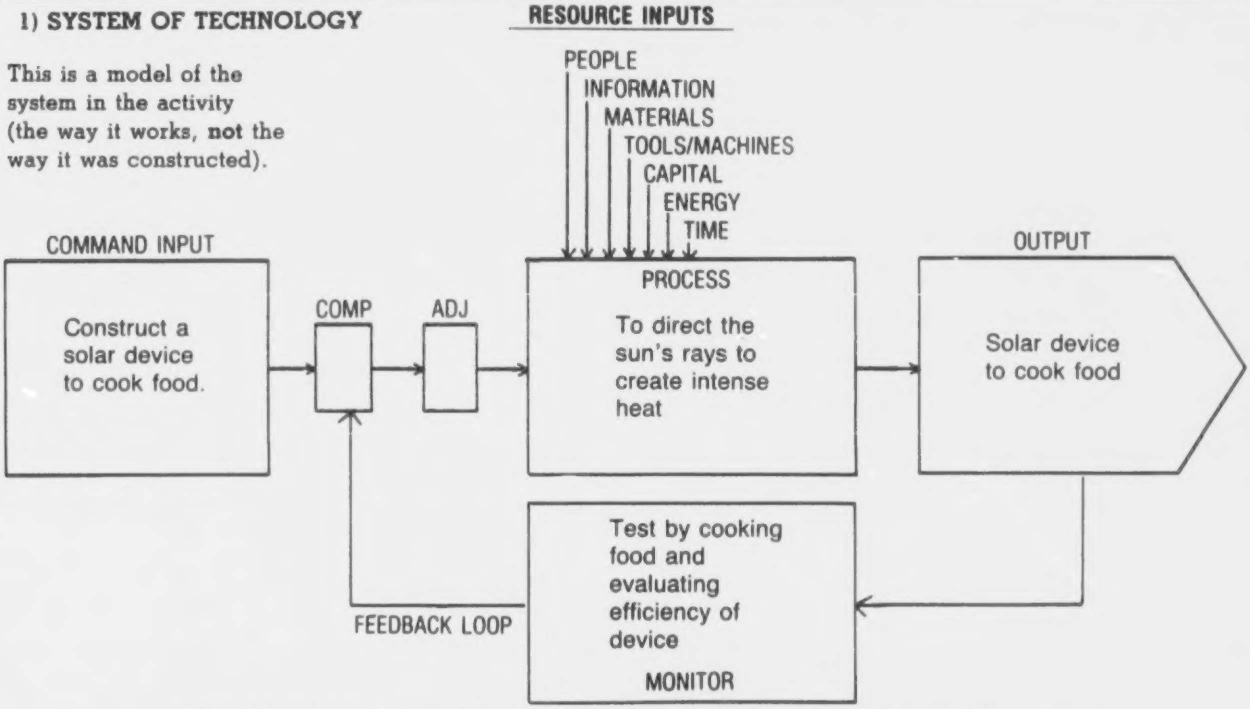
Time Days	POs*	Teacher Activity	POs*	Student Activity
1	3b	Using energy resources in this country as an example, teacher asks students to list appropriate alternative to fossil fuels as a means of supplying energy.	3b	List alternative to fossil fuel based on experiences and knowledge.
3	3c	Assign the following homework: • compare the U.S. resources used to supply food and energy to that of a developing country. • suggest alternative resources when appropriate.	3c	For homework, compare, suggest alternatives, and report on findings.
	PO3	Discuss results of research.	PO3	Participate in discussion of alternative resources to meet human needs.
		Review for Module 2 test.		Take test on Module 2.
22-25 Total Days				

*See Syllabus for phrasing of performance objectives and supporting competencies.

CONSTANTS FOR INFUSION INTO THE TLA

1) SYSTEM OF TECHNOLOGY

This is a model of the system in the activity (the way it works, **not** the way it was constructed).


RESOURCE INPUTS
PEOPLE
INFORMATION
MATERIALS
TOOLS/MACHINES
CAPITAL
ENERGY
TIME
COMMAND INPUT
Construct a solar device to cook food.
COMP
ADJ
PROCESS
To direct the sun's rays to create intense heat
OUTPUT
Solar device to cook food
Test by cooking food and evaluating efficiency of device
MONITOR
FEEDBACK LOOP

IDENTIFY THE ROLE OF THE FOLLOWING RESOURCES IN THE SYSTEM ABOVE:
PEOPLE, INFORMATION, MATERIALS, TOOLS & MACHINES, CAPITAL, ENERGY, TIME

2) MATH - Geometry of plotting a parabola; reflection angle of incidence and angle of refraction.

3) **SCIENCE** - Properties of materials; light energy to heat energy; define energy; refraction.

4) **HUMAN & SOCIAL IMPACTS** - Energy conservation, pollution, and responsibilities to future generations; alternative resources for developing countries.

5) **COMMUNICATION SKILLS** - Developing research skills, drawing plans, reading plans, communicating with the teacher and other students.

6) **SAFETY AND HEALTH** - Safe use of tools and machines; the effects of processing resources on the environment.

7) **PSYCHOMOTOR SKILLS** - Eye hand coordination; fine and gross motor skills.

8) **CAREER RELATED** - Career investigation into the areas of engineering, math, science, and other related fields.

9) **CREATIVE PROBLEM SOLVING** - Opportunities for creative problem solving will be provided by this TLA including: identification and definition of a problem, goal and criteria setting, generation of alternative solutions and recognition of limitations, optimization, testing, and evaluation.

10) **TRANSFER OF LEARNING** - Active and passive solar applications; processing light energy into other energy forms.

BACKGROUND REFERENCES AND RESOURCES

Electrical Power Research Institute. *Electricity Today: Technologies, Tomorrow's Alternatives.* 1982. Pub. Communications Division, EPRI, P.O. Box 10412, Palto Alto, CA 94303.

Householder, Daniel L. & Marshall, John. "An Introduction to Solar Energy," *Industrial Education,* Sept. 1984.

Huntley, Lawrence H. "Cooking With Solar Energy," *School Shop,* February 1980.

EVALUATION

The teacher should develop a two component evaluation system to determine if the student understands: (1) performance objectives and (2) skills, attitudes, knowledge & safety related to the specific lab activity.

(1) EVALUATION OF PERFORMANCE OBJECTIVES (Examples)

1. List the seven resources common to all technological events and give an example of how each may be used in a technological endeavor. PO1.

2. Identify how the lack of certain resources can affect the technological development of nations. Give specific examples of the resource and impacts upon that culture. PO2.

3. List appropriate alternative resources for energy, capital, and information that might be used by third world nations to open technological growth. PO3.

4. Define and give examples of renewable and nonrenewable resources. 3a.

(2) EVALUATION OF SKILLS, ATTITUDES, KNOWLEDGE & SAFETY (Examples)

1. Define the term "properties" as in material properties. Give examples of common properties we usually test for.

2. Why was a parabolic curve used in the design of the food cooker?

3. In the solar cooker, light energy was changed to heat energy. Give an example of a product that changes heat energy into light energy.

4. Give two processing methods that can be used to separate materials.

5. Give two processing methods that can be used to join materials.

6. Give another example of how parabolic collectors are used to concentrate energy.

APPENDIX: SOLAR COOKER

SOLAR COOKER

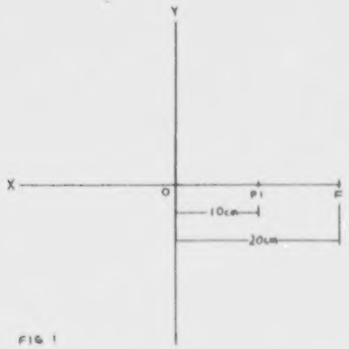
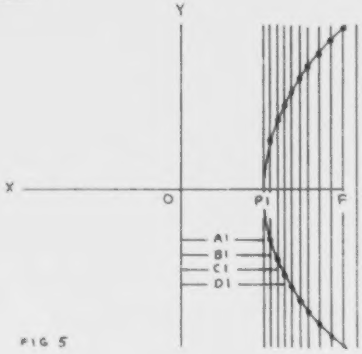

Y
X
O
P1
F
10cm
20cm

FIG 1


Y
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A1
B1
C1
D1

FIG 5

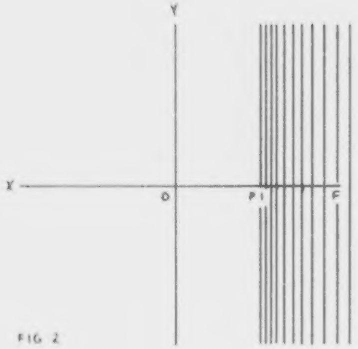
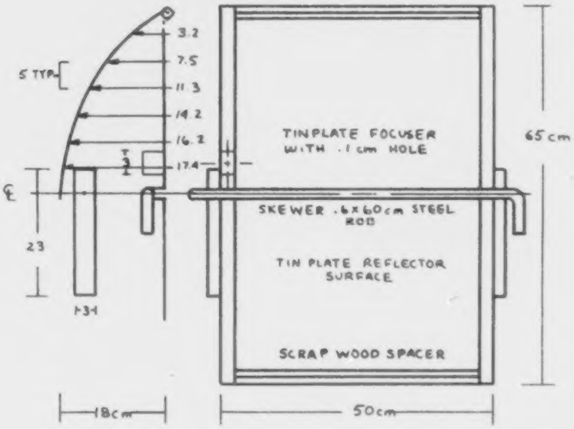


FIG 2


3.2
7.5
11.3
14.2
16.2
17.4
5 TYP
3
℄
23
3
18cm
TINPLATE FOCUSER WITH .1 cm HOLE
SKEWER .6x60cm STEEL ROD
TIN PLATE REFLECTOR SURFACE
SCRAP WOOD SPACER
65cm
50cm

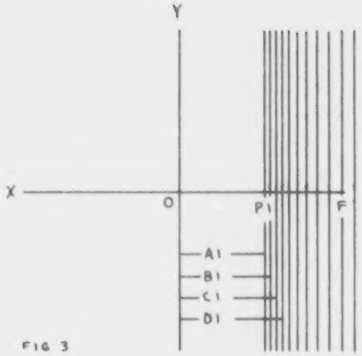

Y
X
O
P1
F
A1
B1
C1
D1

FIG 3

INTRODUCTION TO TECHNOLOGY TECHNOLOGY LEARNING ACTIVITY

ENERGY TRANSFER DEVICES

MODULE NUMBER: T-3
NUMBER OF DAYS: 15-20

MAJOR CONCEPTS TO BE ADDRESSED

T-3A There are formalized methods (systems) used to solve technological problems or make technological decisions.

T-3B The problem-solving process includes design (planning) and implementation.

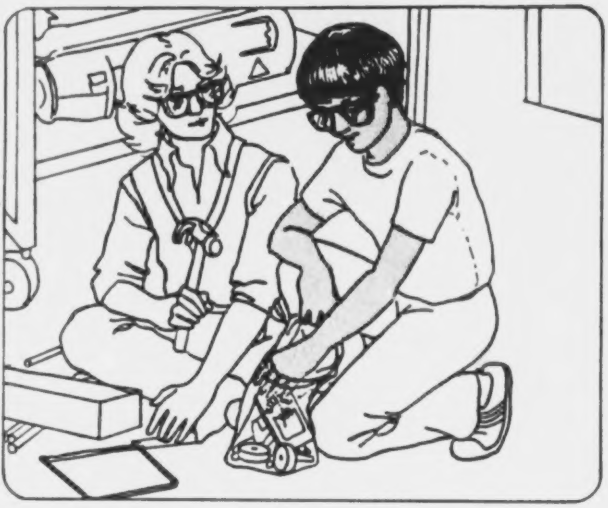
T-3C An important part of the problem-solving process involves the generation of alternatives and the search for optimal solution(s).

T-3D Optimization of a solution normally requires tradeoffs in order to best meet the specified design criteria.

T-3E Modeling techniques (see definition in syllabus glossary) are useful problem-solving aids.

T-3F Some problems cannot be solved by technology because of constraints imposed by the scientific principles, resource limitations, and constraints resulting from people's values and attitudes.

OVERVIEW OF TLA



In this TLA, teams of students will practice problem solving techniques through the design and construction of either a mousetrap powered vehicle, a rubberband powered boat, or a rubberband powered flying craft. In doing so, the student will explore and experience how people can solve technological problems by using a formalized problem-solving system. Students will complete the design and build one of the devices. One hundred dollars in play money will be given to each team. A basic bag of parts is purchased for $25.00. The teams will have the opportunity to buy additional parts or rent needed tools. A distance competition will be held and results discussed. Concepts will be developed relating to the students' shared experience.

EQUIPMENT AND SUPPLIES

- Ziplock bag containing mousetrap, rubberbands, clothespins, string, beads, wheels, push pins, play money, dowels, etc. (and modified glider kit if applicable)
- Additional materials available for "purchase": nails, pop rivets, tubing, tape, wood slats, etc.
- Tools available for "rent": hot glue gun, saws, hammers, other hand tools

PROCEDURE FOR THIS ACTIVITY

Days	POs*	Teacher Activity	POs*	Student Activity
1	1a	Introduce problem solving. Explain how technological problems are solved through a formalized problem solving approach. Introduce the formal method to solve problems.	1a	Homework: Given a common problem, use the formal problem-solving method to implement the optimal solution to the assigned problem in each of the three areas of technology.
1	1a	Review the problem-solving procedure. Lead discussion of student answers to homework assignments.	1a	Present solutions to the three technological problems "solved" for the previous night's homework.
1-2	1b	Identify and define the problem (design and construction of either a mousetrap or rubber-band powered device). Set resource limitations. Introduce scientific and mathematic concepts of friction, measurement, kinetic and potential energy, lift, basic aerodynamics, etc.	1c	Take notes and participate in lesson by asking and answering questions.
1-2	1d	Appropriate instruction in hand tools and safety.		Purchase material with play money. Begin to discuss problem.
1-2		Move about class to provide instruction if needed.	1a	Brainstorm for alternative solutions.
		Facilitate activities, giving lessons where needed.	1b	Employ laboratory based activities such as technical drawings, sketches, illustrations, computer simulations to develop design of the device.
3-5		Move about class to provide instruction if needed. Demonstrate safe use of materials, tools/equipment, processing, etc.	1a 1d PO1	Continue to utilize the formal problem-solving method to develop and refine ideas. Use materials, tools, instruments, equipment, and procedures safely in the laboratory during the building and refinement of the device.
1		Conduct trial runs of prototype. Begin discussion of qualities of vehicle.	1c PO1	Collect, organize, and evaluate data from prototype. Revise the device.
1	1c	Contest will be held, results listed. Assist students in preparing oral presentations.	 1c	Run devices individually. Analyze data. Calculators or computers may be used to analyze results. Explain principles used in device.
1	2a	Introduce concept that technology is limited by scientific principles.	2a	Explain how device was limited by scientific principles.
1		Discuss scientific principles of stored energy. Discuss energy sources for transportation and propulsion. Discuss environmental impact of automobiles.	 2b	Give examples of other energy storage devices and of other sources of energy (historical) used to propel devices. Identify the resources that were needed to construct device.

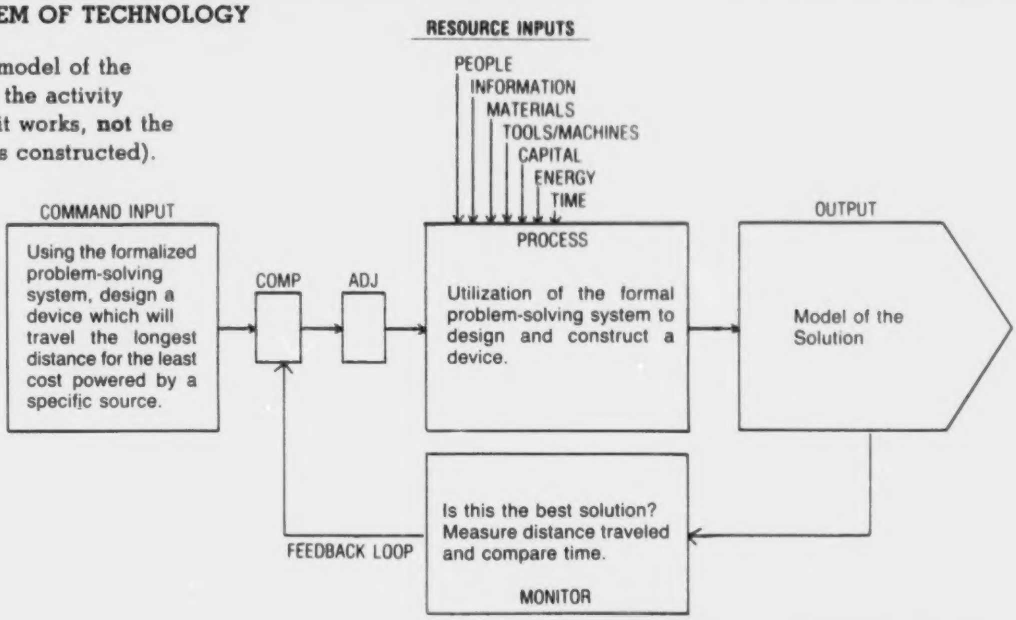
Days	POs*	Teacher Activity	POs*	Student Activity
1	2a 2b 2c	Discuss relationship among speed, mass, and force. Discuss optimization and trade-offs. Give transfer of knowledge examples.	2c	Participate in discussion. Homework: For the three aspects of technology, identify how scientific principles limit technology and identify the limitations imposed by the seven technological resources.
	PO2	Lead discussion on homework assignment. Relate student model to technological problems in society. Assign problems in the three aspects of technology.	PO2	Discuss homework assignment. Identify constraints, resource limitations, values, and scientific principles for the assigned problems.
1		Administer exam on Module T-3.		Take test.
1		Use this activity as an introduction to the "systems" module, i.e., What was the desired result? The process? The actual result? Was the system monitored? What (or who) provided the comparison and the adjustment (controls)?		Review experience in "systems" terms, identifying the feedback received from trials and errors, the desired and actual results.
15-20 Total Days				

*See Syllabus for phrasing of performance objectives and supporting competencies.

CONSTANTS FOR INFUSION INTO THE TLA

1) SYSTEM OF TECHNOLOGY

This is a model of the system in the activity (the way it works, **not** the way it was constructed).


RESOURCE INPUTS
PEOPLE
INFORMATION
MATERIALS
TOOLS/MACHINES
CAPITAL
ENERGY
TIME
COMMAND INPUT
Using the formalized problem-solving system, design a device which will travel the longest distance for the least cost powered by a specific source.
COMP
ADJ
PROCESS
Utilization of the formal problem-solving system to design and construct a device.
OUTPUT
Model of the Solution
FEEDBACK LOOP
Is this the best solution? Measure distance traveled and compare time.
MONITOR

IDENTIFY THE ROLE OF THE FOLLOWING RESOURCES IN THE SYSTEM ABOVE:
PEOPLE, INFORMATION, MATERIALS, TOOLS & MACHINES, CAPITAL, ENERGY, TIME

2) MATH - Calculate average distance. Calculate cost-effectiveness (performance/cost).

3) SCIENCE - Discuss relationship of potential energy (spring, rubberband) to kinetic energy (motion of vehicle). Additional examples of potential or stored energy are batteries and water behind a dam. Apply other science concepts, such as: friction as a force that resists motion. Change in momentum (MV) is affected by the magnitude of a force and the time that the force is applied. The inertia or mass of the vehicle affects the speed that it can attain.

4) HUMAN & SOCIAL IMPACTS - Discuss the implications of trading off effectiveness for cost savings. Consider environmental implications of materials utilization and pollution free vehicle.

5) COMMUNICATION SKILLS - Students will keep a log of design changes - see Appendix: Specification Sheet, present a verbal explanation of the design concepts used in their solution, and display competition data in a chart.

6) SAFETY AND HEALTH - Assure the safe use of hand tools, hot glue, and the use of proper eye protection. Demonstrate the safe handling of the spring mechanism. Establish procedures for clean-up.

7) PSYCHOMOTOR SKILLS - Students will develop or improve hand-eye coordination and manual dexterity. Specific skills will vary according to techniques and tools selected.

8) CAREER RELATED - Students will participate in activities used in the fields of industrial design, engineering, modelmaking, and prototype construction. Students will view the job of a Technology teacher.

9) CREATIVE PROBLEM SOLVING - Opportunities for creative problem solving will be provided by this TLA including: identification and definition of a problem, goal and criteria setting, generation of alternative solutions and recognition of limitations, optimization, testing, and evaluation.

10) TRANSFER OF LEARNING - Apply the problem-solving approach to the purchase of a bicycle. Identify criteria, list information needed to develop alternatives and make selection, discuss comparison shopping and methods of evaluation. Relate idea of unit price - cost of item/number or oz., lbs., qt., - as a measure of a "best buy" when discussing cost effectiveness.

BACKGROUND REFERENCES AND RESOURCES

The Physical Sciences. Kisk and Blecha, Laidlaw Brothers, 1971.

Concepts in Physics. Miller, Dillon & Smith. Harcourt, Brace and World, Inc., 1969.

Beginning With Boats. Klein, Thomas Y. Crowell Company, N.Y., 1962.

See high school physics textbook for discussion of Newton's 2nd Law:

$$F = ma \quad \text{or} \quad \Delta v = \frac{F \times \Delta t}{m}$$

F = force
m = mass
a = acceleration
Δv = change in velocity
Δt = change in time

EVALUATION

The teacher should develop a two component evaluation system to determine if the student understands: (1) performance objectives and (2) skills, attitudes, knowledge & safety related to the specific lab activity.

(1) EVALUATION OF PERFORMANCE OBJECTIVES (Examples)

1. Technical problems are best solved when approached in an organized manner. Number the steps below from 1 to 7 so that they are used in the proper sequence. (PO1)

___7___ evaluate
_______ review date
_______ develop alternative solutions
___1___ define the problem (goal and limits)
_______ test one possible solution
_______ identify the things that can be changed
_______ implement solution

2. Identify common limitations imposed by the 7 resources. (2-b,c)

3. Give the students a common problem in one or more of the aspects of technology. Have the students identify the constraints and classify them. (PO2)

(2) EVALUATION OF SKILLS, ATTITUDES, KNOWLEDGE & SAFETY (Examples)

1. If the weight of a given vehicle in the activity is decreased, then its speed will: (a) increase (b) decrease (c) remain the same.

2. As the friction between the wheel and axle decreases the distance traveled by the mousetrap vehicle:
(a) increases (b) decreases (c) remains the same.

3. Using the information given below, complete the chart and circle the team letter with the highest final score. Round off all calculations to the nearest hundredth (calculators may be used).

4. Which of the following factors is the **least** important in the design of a vehicle which will travel the longest distance? Circle your answer:
(a) mass (b) shape (c) applied force (d) friction

Team	**Distance Traveled**		**Average Distance (Effectiveness)**	**Money Spent (Cost)**	**Final Score Effec./Cost Ratio**
	Trial One	**Trial Two**			
A	8 ft.	11 ft.	____________	$55.00	____________
B	12 ft.	9 ft.	____________	$65.00	____________

APPENDIX: MATH AND SCIENCE CONCEPTS AND OTHER RELATED MATERIALS

MATH

Measurement of distances cars travel in metric (cm) or customary (feet, inches); changing units for calculating average distance; division and rounding numbers in calculation of average distance.

Discuss cost-effectiveness as a ratio of:

$$\frac{\text{effectiveness}}{\text{cost}} = \frac{\text{average distance}}{\text{money spent}}$$

Students will have to divide and round quotient to nearest hundredths (division of decimals).

Example from chart - CE $= \frac{9.5 \text{ ft.}}{\$55} = .17$ ft./$1

$$\begin{array}{r} .172 = .17 \text{ ft.} \\ 55\overline{)\,9.500} \\ \underline{55} \\ 400 \\ \underline{385} \\ 150 \end{array}$$

Compare "cost effectiveness ratio" with "unit price of" as measure of "best" for your money.

SCIENCE

1. Energy is divided into two general types - kinetic and potential.
2. **Kinetic energy** - energy imparted to an object when work is done on the object.
3. **Potential energy** - energy stored in an object due to its position or condition.
4. When a spring is being compressed, kinetic energy is being changed to potential energy.
5. When a spring is fully compressed, it has maximum potential energy.
6. When a spring is allowed to uncoil, potential energy is changed back to kinetic energy.
7. Acceleration of an object is the change in its velocity per unit of time.
8. Acceleration is inversely related to the mass of an object.

SCIENCE (Continued)

9. Friction is a force that is opposite to force causing work to be done.
10. Friction causes a loss of kinetic energy to some other form of energy, quite often heat.

Friction Buoyancy

Instructional Objectives

1. At the conclustion of this lesson each student will be able to:
   a) Define friction, force, buoyancy, and displacement (inertia).
   b) Apply these concepts to the rubberband powered boat.
   c) Describe how weight will affect the boat.

Helpful Experiences

1. Show how much farther a piece of wood travels on water compared to travel on the desk top. Water is a smooth surface with little friction.

2. Students list example of materials which float. A discussion should follow. Explain buoyancy as a force which acts upward.

3. Put four materials in separate beakers to demonstrate rise in the water level (displacement).

4. Put a stick of wood in the water, add weight to one end; it will sink. Try to put weighted end on top, it will tip over. Refer to the construction of the rubberband powered boat.

Energy (Potential and Kinetic)

Instructional Objectives

1. At the conclusion of this lesson each student will be able to:
   a) Define potential and kinetic energy.
   b) Identify examples of potential and kinetic energy.
   c) Apply the concepts of potential and kinetic energy to the rubberband powered boat activity.

Helpful Experiences

1. String a rubberband through a button and twist. Place the twisted device into a plastic bag. Explain that it is full of "snake eggs." Have a student open it. The rubberband will unwind making a ticking noise from the button. Explain that the twisted rubberband is an example of potential energy, and untwisting is an example of kinetic energy.

2. Transparency of terms and definitions.

3. List more examples - blow up a balloon and release.

4. Have students cut out models of a paddle or propeller from cardboard, test with a rubberband.

APPENDIX: DESCRIPTION OF THE PROBLEM

SIMULATION - MOUSETRAP/RUBBERBAND POWERED DEVICE

The Problem

Design a device to transport itself as far as possible. The source of power to be used is a standard, regular, normal everyday mousetrap or rubberband.

A. Criterion

The objective is to design and build a device that has the highest effectiveness/cost ratio.

B. Limitations.

1. The only source of energy is the typical mousetrap or rubberband provided.
2. A maximum of $100.00 play money can be spent on tools and supplies, including the mousetrap and rubberband.

C. The Competition

Students will be in teams. Each member of the team will take a turn in the competition. The distances will then be averaged. Each competitor will take his/her turn individually. The final score is based on an effectiveness/cost ratio - feet per dollar. After each team player takes a turn, the distances traveled will be averaged. This number will then be divided by the money spent. The highest ratio will be the most distance for the least cost.

(Round off all calculations to the nearest hundredth.)

Team	Distance Traveled		Average Distance	Money Spent	Final Score
	Trial One	Trial Two	(Effectiveness)	(Cost)	Effect./Cost Ratio
A					
B					
C					
D					

Design Notes: Keep track of trial distances and design changes.

APPENDIX: PURCHASE LOG

TECHNOLOGY EDUCATION

NAME ______________________ PERIOD __________

PARTNERS' NAMES ______________________

PURCHASE LOG

DATE	DESCRIPTION OF ITEM RENTED OR PURCHASED	PRICE
	TOTAL	

APPENDIX: IDEA LOG

NAME ______________________________ PERIOD __________
PARTNERS' NAMES ______________________

Problem Solving Procedure:

1. Identify and define the problem
2. Set goals and identify criteria
3. Generate alternatives and consider limitations
4. Select the optimal solution
5. Implement solution
6. Evaluate the results and make modifications, as necessary
7. Evaluate the results.

Which methods of problem solving did you use? Cite examples.

1. Trial and error
2. Brainstorming
3. Working backwards

Indicate examples of where you modified your original design in order to overcome problems. ____________

LOG OF IDEAS, CHANGES, PROBLEMS, PROGRESS

DATE	ORIGINAL IDEAS	MODIFICATIONS

APPENDIX: MATERIALS LIST

RUBBERBAND POWERED DEVICE

NAME ______________________________ PERIOD __________
PARTNERS' NAMES ______________________ BAG # __________

MATERIALS LIST

Parts inventory: The bag of parts you purchased should contain the following items. Put a check next to the items you have.

__________ Flat board 4 x 6"*
__________ Flat board 2-7/8 x 8"
__________ 3/16" dia or 1/4" dia dowel
__________ 2 small nails
__________ 2 push pins
*Can sell for $5

__________ 24" of string
__________ 2 wood sticks
__________ 1 rubberband
__________ $100 in technology money
(Count and put your name on the back of each bill.)

APPENDIX: MATERIALS LIST (Continued)

EXTRA PARTS

The following parts may be purchased. Price subject to change without notice.

3/16" dia or 1/4" dia dowel rods - $3
1/2" dia dowel rods - $5
Rubberband (any size) - $5
Nails - 2 for $1
Push pin - $1
Screw - $1
Woodstick - $2
Wood 2-7/8 x 8" - $4
Wood 1-5/8 x 8" - $4
Wood 4" x 6" - $5
String - 10 cents per inch*
Plastic - 10 cents per square inch*
Styrofoam - 10 cents per square inch*
New ditto - $2

*Amount purchased must be in dollars

TOOLS AND MACHINES

The following tools and machines may be rented. Prices subject to change.

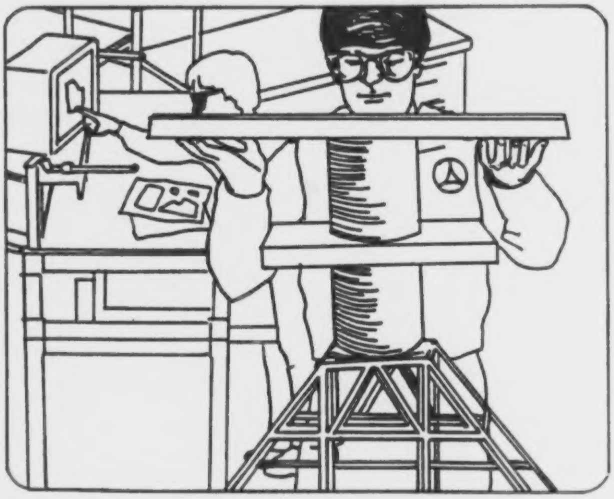
Jig saw - $10
Small band saw - $10
Drill Press - $10
Sander - $5
Glue Gun - $10
Duco Cement - $2
Wood glue - $2
Brush - $3
Hand tools (each) - $4
Sandpaper - $4

PENALTIES:
Poor clean up - $2
Other - $2

NOTE: Only the parts listed on this sheet may be used to make the rubberband powered device, unless other parts are made available by the instructor.

INTRODUCTION TO TECHNOLOGY TECHNOLOGY LEARNING ACTIVITY

LOAD BEARING STRUCTURE - DESIGN PROBLEM



MODULE NUMBER: T-3
NUMBER OF DAYS: 15-20

MAJOR CONCEPTS TO BE ADDRESSED

T-3A There are formalized methods (systems) used to solve technological problems or make technological decisions.

T-3B The problem-solving process includes design (planning) and implementation.

T-3C An important part of the problem-solving process involves the generation of alternatives and the search for optimal solutions(s).

T-3D Optimization of a solution normally requires tradeoffs in order to best meet the specified design criteria.

T-3E Modeling techniques (see definition in syllabus glossary) are useful problem-solving aids.

T-3F Some problems cannot be solved by technology because of constraints imposed by the scientific principles, resource limitations, and constraints resulting from people's values and attitudes.

OVERVIEW OF TLA

In this TLA, groups of students will solve technological problems related to load bearing structures which will be built and tested. A formalized problem-solving system will be used. Ideas covered will include design, optimization, constraints, and limitations. Plans for a testing device to be built by the teacher are included in the TLA.

EQUIPMENT AND SUPPLIES

- Miniature wood beams: balsa, pine, veneer (selection depends on availability and structure being developed)
- Hand and machine tools including: x-acto knife, hand saw, jig saw, etc.
- Ruler, pencil
- Various adhesives: Elmer's Carpenters Glue, Duco Cement, Testors Quick Drying Cement
- Hot glue gun
- Clothes pins for clamps
- "Structure crusher" and weights

PROCEDURE FOR THIS ACTIVITY

Days	POs*	Teacher Activity	POs*	Student Activity
1		Introduce formal problem-solving method. Hand out flow-chart. Do not identify all steps at this time Discuss 1 day design activity. Introduce trial and error, brainstorming, and working backwards.	1a	Identify and define the problem. Set goals and identify criteria. Homework: Define enabling vocabulary in notebook. Prepare ideas to solve 1 day problem.

LOAD BEARING STRUCTURE - DESIGN PROBLEM

Days	POs*	Teacher Activity	POs*	Student Activity
2		Conduct brainstorming session.	1b 1d	Brainstorm alternatives. Begin construction of solution.
1	1c	Facilitate testing of solutions to problems.	1c	Test solutions to problem.
1	1a	Identify remaining blocks in formal problem-solving flowchart. Utilize previous day's problem, module 1 and 2 modeling activities. Facilitate discussion. Give students flowchart similar to the one in the Syllabus.	1a 1c	Fill in formal problem-solving flowchart. Homework: List examples of structures encountered in everyday life.
1	PO1	Discuss principles related to load bearing structures - terms, truss concepts, load, types of bridges, towers, and foundations. Hand out design problems (see appendix). Identify 7 resources in problem. List limitations imposed. Understand concepts of physics that apply to the chosen problem.	1a 2a 2b 2c PO1	Continue to fill in problem-solving flowchart. Define related terms. Record and understand resource limitations. Recognize appropriate scientific principles (see physics text for ideas). Fill out handout sheet. Use library reference books, etc., to begin solving problems.
1		Facilitate development of technical sketch of problem.		Develop a technical sketch of the solution.
3-8	PO1	Facilitate construction and identification of formal problem solving steps. Give machine/tool demonstrations, safety, etc., as needed.	1d PO1	Use machine/tools and materials safely in construction of structure. Collect, organize, modify, and evaluate data during construction.
1		Monitor presentations.	1c	Give presentation to the class on methods used to solve problems. Incorporate proper terms, scientific principles to defend design.
1		Test load bearing structure.		Record test data, analyze results.
1	PO2	Present problems in 3 areas of technology. Student will identify constraints, resource limitations, etc. (relate structure built to real life problem).	PO2	Outline problems. Homework: Identify constraints, resource limitations, and concepts of physics in the 3 assigned problems. Include attitudes of people.
1	PO2	Lead group discussion and evaluation of 3 problems.	PO2	Organize and evaluate data.
1		Review activity and syllabus module content.		Take test on activity learning, syllabus performance objectives, and skills utilized in the activity.
15-20 Total Days				

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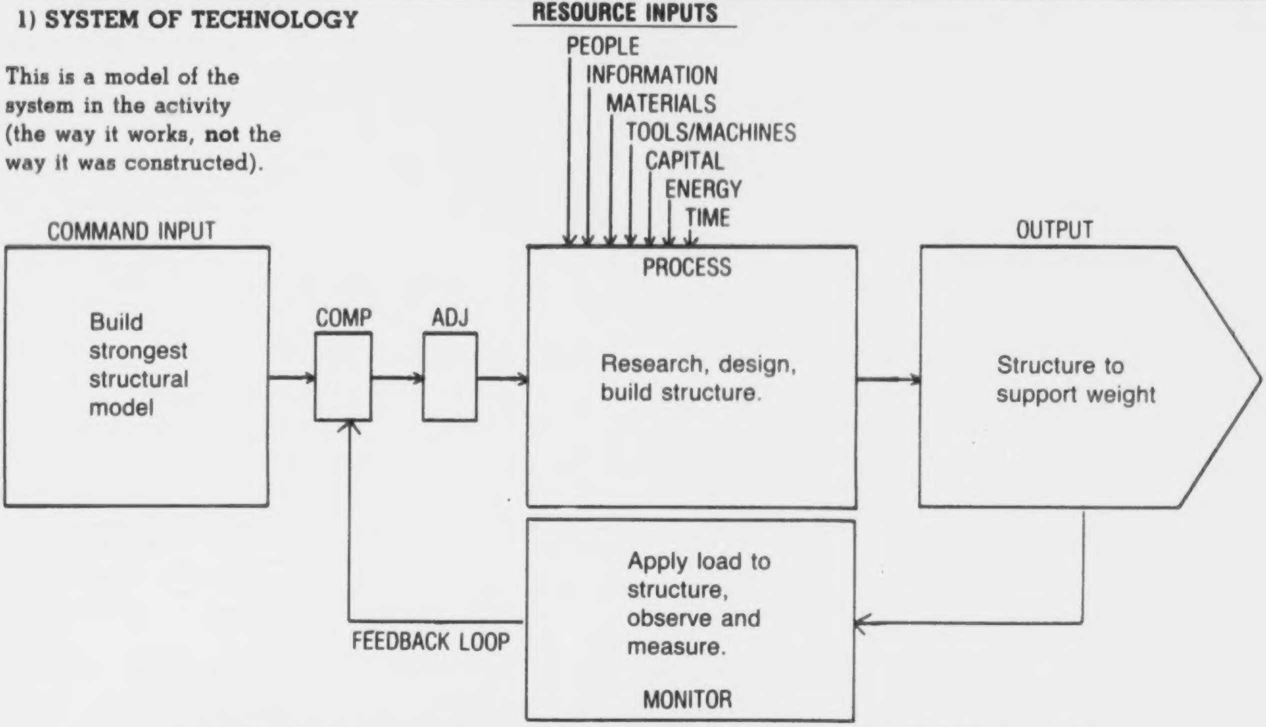
*See Syllabus for phrasing of performance objectives and supporting competencies.

CONSTANTS FOR INFUSION INTO THE TLA

1) SYSTEM OF TECHNOLOGY

This is a model of the system in the activity (the way it works, **not** the way it was constructed).


RESOURCE INPUTS
PEOPLE
INFORMATION
MATERIALS
TOOLS/MACHINES
CAPITAL
ENERGY
TIME
COMMAND INPUT
Build strongest structural model
COMP
ADJ
PROCESS
Research, design, build structure.
OUTPUT
Structure to support weight
Apply load to structure, observe and measure.
MONITOR
FEEDBACK LOOP

IDENTIFY THE ROLE OF THE FOLLOWING RESOURCES IN THE SYSTEM ABOVE:
PEOPLE, INFORMATION, MATERIALS, TOOLS & MACHINES, CAPITAL, ENERGY, TIME

2) MATH - Measurement (weight of structure, dimensions of structure), calculate load bearing capacity to mass of the structure. Calculate the load placed on the structure.

3) SCIENCE - Explain how vector forces affect the outcome of the problem. Relate load displacement to solving problems.

4) HUMAN & SOCIAL IMPACTS - Use of team approach to problem solving and decision making. Discuss implication of improper maintenance of bridge structures to society. Building techniques considerations for environmental aspects and aesthetics. In the United States numerous roads, bridges, and other public facilities have been constructed during the last 100 years. Many of these are now in need of repair or replacement and a class discussion should explore how this can be done given the high costs involved.

5) COMMUNICATION SKILLS - Students will keep a record of brainstorming ideas and design changes. Students produce technical sketches, present a verbal explanation of design concepts used in their solution.

6) SAFETY AND HEALTH - Review safe use of tools, materials, and adhesives. Precautions during testing should include safety glasses.

7) PSYCHOMOTOR SKILLS - Students will develop or improve hand-eye coordination. Students will improve manual dexterity.

8) CAREER RELATED - Careers in industrial design, engineering, model making and proto-type construction, architecture.

9) CREATIVE PROBLEM SOLVING - Opportunities for creative problem solving will be provided by this TLA including: identification and definition of a problem, goal and criteria setting, generation of alternative solutions and recognition of limitations, optimization, testing, and evaluation.

10) TRANSFER OF LEARNING - Design other structures from homes to aerospace vehicles. Team experience to acquire new knowledge. Critical thinking. Learning can take place even though mistakes. Packaging and container design considerations.

BACKGROUND REFERENCES AND RESOURCES

- Olympics of the Mind activities.
- High school physics book - vectors, energy, and stresses
- Engineering - Technical Drafting book - trusses, girders, and long span framing
- Descriptive geometry text - truss bridges

Anne and Scott McGregor. *Bridges - A Project Book.* N.Y.: Lothrop, Lee & Shephard Books, 1980.

Henry Billings. *Bridges.* N.Y.: The Viking Press, 1958.

Scott Corbett. *Bridges.* N.Y.: Four Winds Press, 1978.

Charles Gamet. *Highways Across Waterways - Ferries, Bridges and Tunnels.* N.Y.: Abelard-Schuman, 1978.

Super Structures. N.Y.: The Viking Press, 1980.

EVALUATION

The teacher should develop a two component evaluation system to determine if the student understands: (1) performance objectives and (2) skills, attitudes, knowledge & safety related to the specific lab activity.

(1) EVALUATION OF PERFORMANCE OBJECTIVES (Examples)

1. Each student will identify a problem encountered in everyday life. S/he will then fill in a formalized problem-solving flowchart for the solution of the problem. PO-1

2. Given a blank flowchart of problem solving, the student will fill in the steps involved in problem solving. 1a

3. Identify common limitations imposed by the 7 resources. 2-b,c

4. Give examples of scientific principles that are encountered in everyday life (ex. force, motion, work, kinetic theory, thermal, sound; see physics book). 2a

5. Create a matching test for the enabling vocabulary.

6. Give a short answer test with questions drawn from the performance objectives and supporting competencies.

7. Give the students a common problem in one or more of the aspects of technology. Have the students identify the constraints and classify them. PO-2

(2) EVALUATION OF SKILLS, ATTITUDES, KNOWLEDGE & SAFETY (Examples)

Teacher will evaluate:

- The group presentation on how the problem was solved.
- The participation of individual group members.
- The performance of the group as a whole.
- Individual technical sketches of the structure.
- The recording of data and the conclusions drawn.
- The workmanship of the model constructed.
- The testing of individual structures.
- Conclusions and observations made by students at the end of the TLA.

APPENDIX: BRIDGE DESIGN PROBLEM

PROBLEM: Groups of 3-4 students will construct a bridge that must span a distance of 35 centimeters without touching the floor of the structure crusher that will be used for testing. Students will be given 50 miniature wood beams to construct the bridge. Various adhesives and tools can be used for the construction. Bridges will be tested to see which will hold the greatest amount of weight. The mass weight of the bridge is important, as the winning group will have to produce the strongest bridge compared to the weight of the bridge.

USE THE PROBLEM-SOLVING METHOD TO PROCEED:

1. Define the problem.
2. Identify the specifications (limits, constraints).
3. Survey available technological resources (books, reference material).
4. Identify alternative technological solutions.
5. Select the optimal solutions.
6. Evaluate the results.
7. Make modifications as necessary.

TRY THESE METHODS:

1. Trial and error.
2. Brainstorming.
3. Working backwards.

SPECIFICATIONS: (Limitations, Constraints)

1. Your group will be given 50 wood beams approximately 2 mm thick, 7 mm wide, and 15 cm long. The beams can be cut and shaped any way that is necessary to solve the problem.

2. The bridge must span a distance of 35 centimeters. Make sure your bridge is longer than this to span the distance. Supports cannot run to the floor of the "structure crusher" that will be used to test the bridge.

3. The bridge should be no taller than 12 cm and no wider than 10 cm, but the bridge **MUST** be at least 7 cm wide and 7 cm tall.

4. The following tools can be used:
   x-acto knife (use a board to cut on)
   coping saw
   jig saw
   clothes pins for clamps
   ruler
   pencil.

5. The following supplies and materials can be used:
   - 50 wooden beams 2mm x 7mm x 15cm (1/8" x 1/4" x 6") will also work. These can be made of balsa wood, pine, poplar, or other suitable wood.
   - Elmer's Carpenter glue
   - Duco Cement
   - Hot glue gun and glue

   Always glue over scrap paper.

APPENDIX: BRIDGE DESIGN PROBLEM (Continued)

6. Remember the winning bridge must be the strongest and the lightest. Glue will add considerably to the weight of your bridge - use it sparingly. Also remember which of the glues is the strongest for bonding wood from the materials testing done in Module T-2.

HOW TO START:

1. Get together with other members of your group and review the problem-solving method.

2. Brainstorm ideas for solving the problem. List these ideas on the form provided.

3. Survey available technological resources - these are books, magazines, pictures, and other material that your teacher will have available.

4. Each member of the group will develop a technical sketch of the bridge to be constructed. After these sketches are complete, the group will choose one sketch, refine the sketch, and use it as a plan to construct the bridge.

5. Each group member should have an equal part in solving the bridge design problem. Part of your grade will be based on your contribution to the group.

6. Construct the bridge, keeping in mind safety when using tools, equipment, and materials.

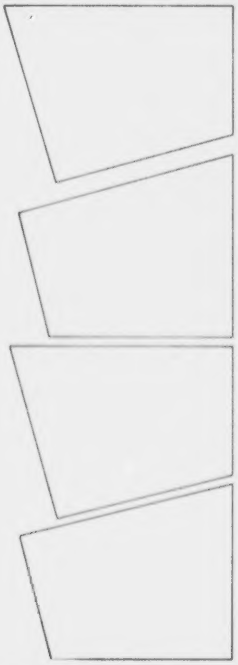
7. Remember, the winning bridge will have to be the strongest and the lightest bridge.

8. Record all design changes and new ideas. This will help with the presentation your group will make to the class. The presentation will be short, but must include an explanation of why your group solved the problem the way it did.

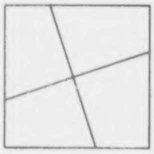
9. Test bridges - group members will weigh their bridge, place it in the structure crusher, add weight and record data.

APPENDIX: SHAPES INTO A SQUARE

Arrange the 4 shapes into a square.



For teacher use: The solution to the trial and error activity will look something like this.



APPENDIX: BUILDING A TOWER

NAMES ______________________________, ______________________________

______________________________, ______________________________

PROBLEM: Design the tallest structure that will hold the greatest amount of weight. Your group will construct a tower using 20 (3x5) cards and ten paper clips. Your group will earn 1 point for each ounce of weight supported and 2 points for every inch of height obtained.

SPECIFICATIONS - LIMITATIONS:

- Cards can be cut
- Cards can be folded
- No glue can be used
- Structure must be at least 1" high
- The winning team will be the one with the greatest number of points

RESULTS:

1. Total height in inches __________ x 2 = __________ points. (Must be figured to the nearest whole inch)
2. Total number of ounces held __________ points.
3. __________ Total Points (sum of lines 1 and 2)
4. Rank with rest of class __________.

APPENDIX: THE LOAD BEARING STRUCTURES - TEST RESULTS

Group Members: 1. ______________________ 2. ______________________

3. ______________________ 4. ______________________

List all the names of group members above. Place your name first.

TEST DATA:

1. What is the mass of your structure? ______________________ grams
2. How much did your structure hold before cracking apart?

______________ Pounds.

______________ Load structure took ÷ weight of the structure.

Find the amount of weight supported by each gram of structured mass by dividing the load the structure took by the mass of the structure.

Answer ______________

3. Out of the groups in your class, check where your structure placed.

__________ 1. The Strongest

__________ 2.

__________ 3.

__________ 4.

__________ 5. The Weakest.

4. List any ideas that you think would have improved your structure.

1. ______________________
2. ______________________
3. ______________________
4. ______________________
5. ______________________
6. ______________________
7. ______________________
8. ______________________
9. ______________________
10. ______________________

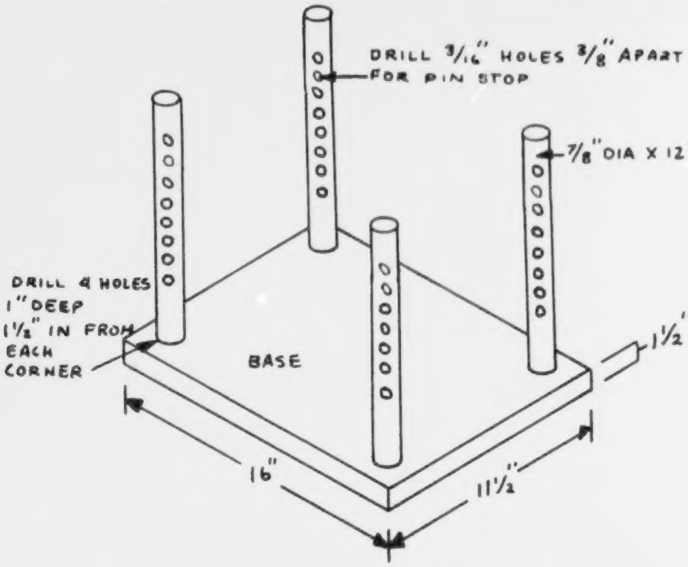
5. Using the numbers by the group member's name listed at the top of the page, place the numbers on the lines below to show who did the following:

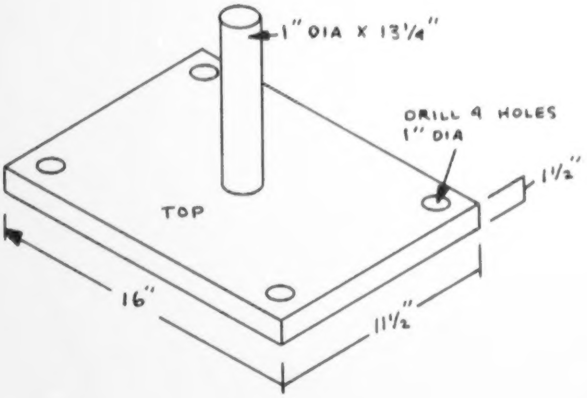
Be Fair

______________ Greatest amount of work ______________ Least amount of work

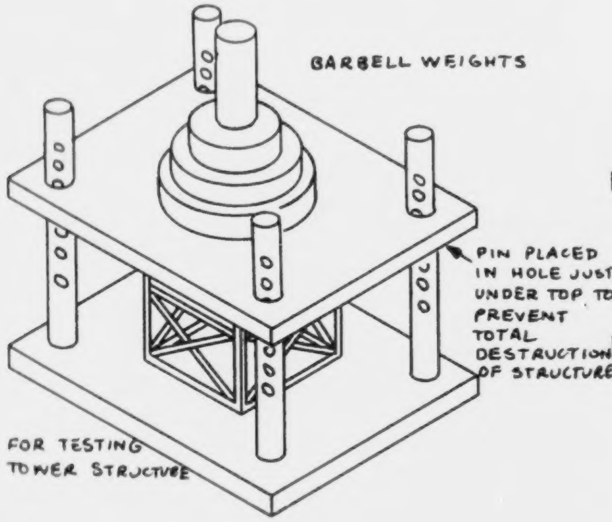
______________ Everybody in the group did the same amount of work.

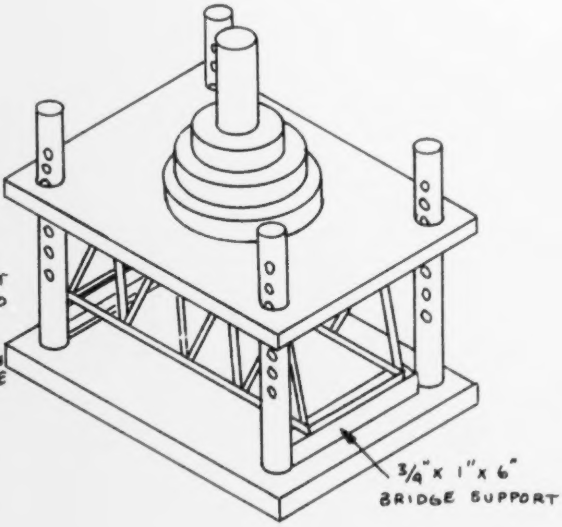
APPENDIX: CRUSHER


DRILL 3/16" HOLES 3/8" APART FOR PIN STOP
7/8" DIA X 12"
DRILL 4 HOLES 1" DEEP 1½" IN FROM EACH CORNER
BASE
1½"
16"
11½"


1" DIA X 13¼"
DRILL 4 HOLES 1" DIA
1½"
TOP
16"
11½"

Remember to add the weight of the top to the total load placed on the structure. Bridge supports should be located at the point that is given in the problem as the distance the bridge has to span.

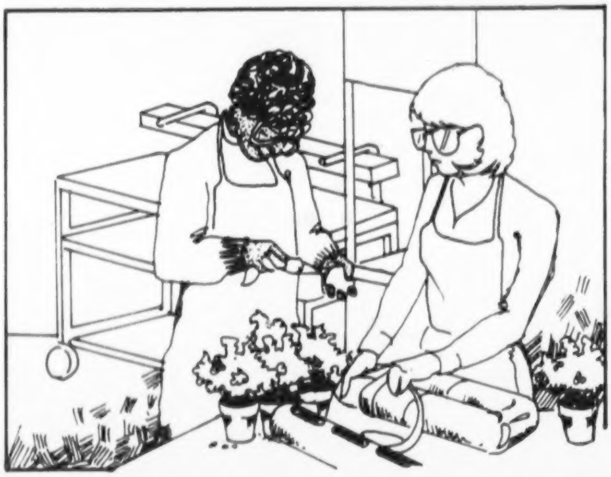

BARBELL WEIGHTS
PIN PLACED IN HOLE JUST UNDER TOP TO PREVENT TOTAL DESTRUCTION OF STRUCTURE
FOR TESTING TOWER STRUCTURE


3/4" x 1" x 6" BRIDGE SUPPORT

Construction idea: 2 x 12 could be used for the construction of the base and top of the structure crusher. Two 3/4" pieces of plywood will also work if they are laminated.

INTRODUCTION TO TECHNOLOGY TECHNOLOGY LEARNING ACTIVITY

PLANTS WITH ONE PARENT



MODULE NUMBER: T-3
NUMBER OF DAYS: 18-34

MAJOR CONCEPTS TO BE ADDRESSED

T-3A There are formalized methods (systems) used to solve technological problems or make technological decisions.

T-3B The problem-solving process includes design (planning) and implementation.

T-3C An important part of the problem-solving process involves the generation of alternatives and the search for optimal solution(s).

T-3D Optimization of a solution normally requires tradeoffs in order to best meet the specified design criteria.

T-3E Modeling techniques (see definition in syllabus glossary) are useful problem-solving aids.

T-3F Some problems cannot be solved by technology because of constraints imposed by the scientific principles, resource limitations, and constraints resulting from people's values and attitudes.

OVERVIEW OF TLA

In this TLA students will study how a technological problem can be solved. The problem studied is the reproduction of large quantities of plants that are identical. Students will study several ways this problem can be solved by modeling different methods of asexual reproduction of plants. Student will also explore and optimize the conditions necessary to maximize plant production.

EQUIPMENT AND SUPPLIES

- Hand tools
- Sharp knife
- Wood to build flats
- Rooting hormone (IAA or Rotone)
- Sterile potting soil
- Sterile small pots
- Several plants each of:
  - Coleus
  - Geranium
  - African Violet
- One mature rubber plant (Ficus)
- Sterile peat moss
- Rubberbands
- Plastic wrap (Saran, etc.)
- Flourescent or Gro-Light light source
- Graph paper
- Notebook to record data
- Timing devices
- Heating cables

PROCEDURE FOR THIS ACTIVITY

Days	POs*	Teacher Activity	POs*	Student Activity
1	PO1	Introduce a formal method for solving technological problems. (Use overheads, handouts, filmstrip, etc.). Discuss technological problem solving (limitations, consequences, effects on human user, etc.).	PO1 1a	Record important information about problem solving (note sheets, worksheets, handouts, etc.).
1	PO2	Introduce problem of reproduction of plants. Discuss differences between sexual and asexual reproduction. Discuss the impacts of cloning plants, animals, and people.	PO2 2a	Participate in discussion.
	PO1	Present the problem.	PO1 1a	Discuss problem goal, criteria, and constraints.
1		Set up groups. Discuss tools and machines needed to make flats and timer for lights. Review safety procedures.		Record important information. Ask questions.
2-5	PO1	Introduce and supervise the construction of flats.	PO1 1b, 1d	Build flats and fill with soil.
1-3		Demonstrate air layering and how to prepare and set up plants for asexual reproduction.	PO1 1b 1d	Slip plants, treat half with hormone and label specimens. Set up notebook to record results. Institute a watering and lighting schedule.
5-8	PO2	Supervise record taking. Instigate discussions about tradeoffs, limitations on technological problem solving (i.e., laws of nature, resource constraints, constraints from people's attitudes and values) and further study of the field of biotechnology.	PO1 1c, 1d PO2 2a 2b 2c	Water plants, record any visible changes in plants, e.g., death, yellowing. Participate in discussion, do worksheets or note sheets, ask questions, use handouts, etc.
1-3	PO1	Supervise data collection.	PO1 1b 1c 1d	Remove five treated and five untreated plants, measure number and length of roots, record data. Diagram each. Average the length of the roots. Re-pot each plant in separate pots.
2		Lead discussion of differences seen between treated and untreated plants and between the three species of plants.	PO1 1c	Discuss the results and compare results between groups.
1-5	PO1	Supervise collection of second set of data.	PO1 1c	Remove the remaining plants and measure size and number of roots; record data; diagram each plant. Re-pot each plant in individual pots.
1-2		Supervise students.	PO1 1c	Graph the results putting the treated and untreated on the same sheet of graph paper.

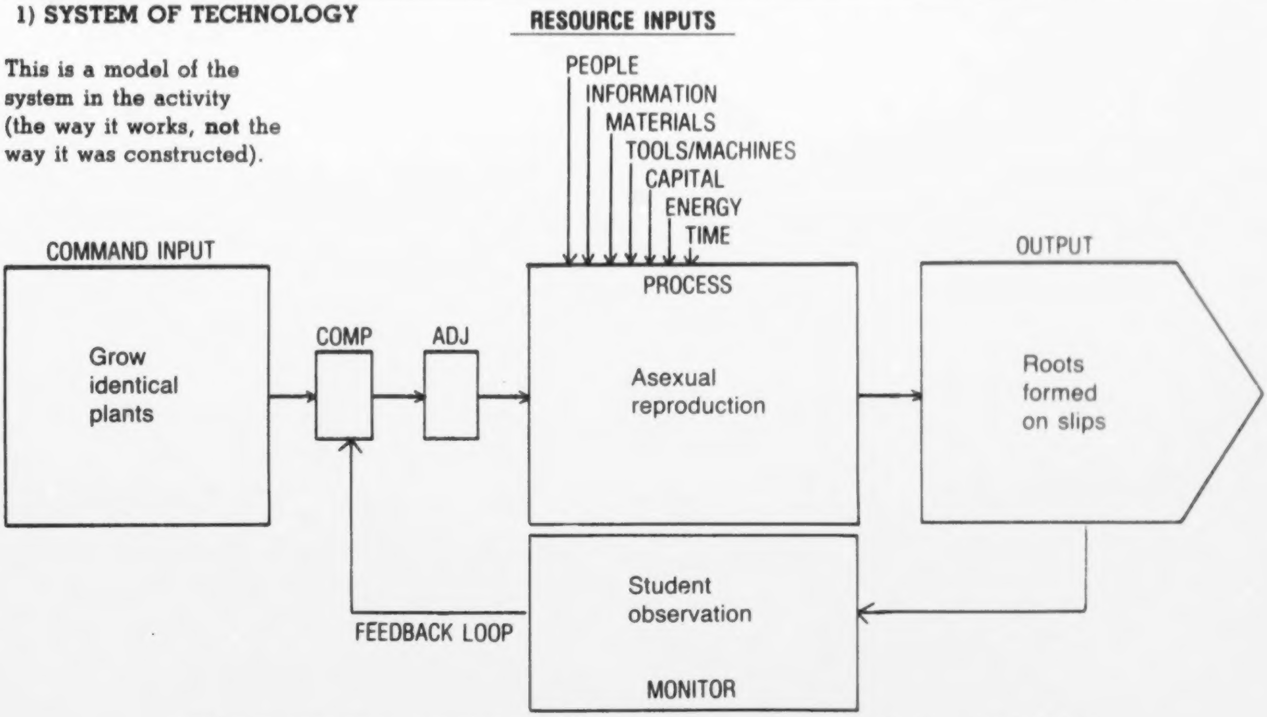
Days	POs*	Teacher Activity	POs*	Student Activity
2-3	PO2	Monitor discussion and presentation.	PO2 2b 2c	Each group prepares and presents to the class a formal report of results, suggests how results may be improved, and what the practical implications are (identify resources, limitations, etc.).
18-34 Total Days				

*See Syllabus for phrasing of performance objectives and supporting competencies.

CONSTANTS FOR INFUSION INTO THE TLA

1) SYSTEM OF TECHNOLOGY

This is a model of the system in the activity (the way it works, **not** the way it was constructed).


RESOURCE INPUTS
PEOPLE
INFORMATION
MATERIALS
TOOLS/MACHINES
CAPITAL
ENERGY
TIME
COMMAND INPUT
Grow identical plants
COMP
ADJ
PROCESS
Asexual reproduction
OUTPUT
Roots formed on slips
Student observation
FEEDBACK LOOP
MONITOR

IDENTIFY THE ROLE OF THE FOLLOWING RESOURCES IN THE SYSTEM ABOVE:
PEOPLE, INFORMATION, MATERIALS, TOOLS & MACHINES, CAPITAL, ENERGY, TIME

2) MATH - Differences, averages, graphing, comparisons.

3) SCIENCE - Asexual reproduction, sexual reproduction, breeding, cloning, hormones, rooting, slipping, temperature, light period, humidity, genetic engineering.

4) HUMAN & SOCIAL IMPACTS - Holidays generate markets which horticultural science can fill by manipulating the propagation of identical plants.

5) COMMUNICATION SKILLS - Ability to work in small groups and prepare and present oral and written reports to a larger group.

6) SAFETY AND HEALTH - Normal laboratory tools and equipment.

7) PSYCHOMOTOR SKILLS - Fine tool skills, measurement of smaller linear distance.

8) CAREER RELATED - Agriculture, horticulture, botany, economics, hobbies.

9) CREATIVE PROBLEM SOLVING - Opportunities for creative problem solving will be provided by this TLA including: identification and definition of a problem, goal and criteria setting, generation of alternative solutions and recognition of limitations, optimization, testing, and evaluation.

10) TRANSFER OF LEARNING - Being able to optimize resources in other situation.

BACKGROUND REFERENCES AND RESOURCES

Bottino, P.J. *Methods in Plant Tissue Culture*. Kemtec Educational Corporation, 1981.

Hartman, Hudson T., et. al. *Plant Science: Growth, Development and Utilization of Cultivated Plants*. Prentice-Hall, 1981.

Janick, Jules. *Horticultural Science*, third edition. W.H. Freeman, 1979.

Kaufman, Peter B., et. al. *Practical Botany*. Reston Publishing Company, 1983.

Raven, Peter H., et. al. *Biology of Plants*. Worth Publishing Company, 1981.

EVALUATION

The teacher should develop a two component evaluation system to determine if the student understands: (1) performance objectives and (2) skills, attitudes, knowledge & safety related to the specific lab activity.

(1) EVALUATION OF PERFORMANCE OBJECTIVES (Examples)

1. Discuss people's values and attitudes which permit cloning of plants but limit applications.

2. Discuss constraints placed upon us by nature which limit the use of asexual reproduction in plants. Mention types of tissue, age of tissue, and time of year when the asexual reproduction is attempted.

3. Why is the genetic engineering of nitrogen-fixing corn or wheat now assumed to be impossible? Why is it important to humans that this problem be solved?

4. Short answer test questions could be drawn from the performance objectives and supporting competencies.

(2) EVALUATION OF SKILLS, ATTITUDES, KNOWLEDGE & SAFETY (Examples)

1. List several means of asexual reproduction in plants.

2. Give examples of plants that are routinely propagated by asexual means.

3. Define cloning and describe how it is being used in plant breeding. What are the future hopes for its use?

4. Discuss the advantages and disadvantages of sexual reproduction in plants.

5. Why did you use sterile materials?

APPENDIX: ACTIVITY BRIEF

Problem: While growing flowering plants, I find a flower with a color never seen before. I am sure it will be a best seller on Mother's Day which is only a few weeks away. How can I increase the number of plants while being sure that all the plants will look like this new flower?

There should be a minimum of three groups. Three students per group seems ideal. Each group should be assigned a plant species and they should make twenty slips. Treat ten with hormone and leave ten without hormone. Push a pencil into the soil to make a hole before putting the slip into the hole so as not to remove the hormone. Firm the soil around the slip.

At this point you can make the TLA as extensive as you wish. You can have groups that test different soil temperatures, air temperatures, humidities, light intensities, and watering schedules. Each situation will require the construction of control mechanisms and measurements devices. Use half of the slips with hormone and half without in each of the alternatives.

APPENDIX: ACTIVITY BRIEF (Continued)

You should demonstrate air layering (See Appendix: Air Layering and references).

In the classroom discussions be sure to mention cloning and genetic engineering and show how they are different from each other. You may wish to discuss the world food problem and how some of the techniques students are studying may be used to help.

Data collection and analysis should be followed by both written and oral reports.

A trip to a commercial greenhouse at the beginning of week four fits very nicely. A TLA on photoperiod and flowering might follow this one.

APPENDIX: TIP CUTTINGS

Propagation by tip cuttings simply means cutting off a piece of a plant's stem, rooting it, and planting the cutting in its own container to be grown on. By so doing the number of plants of a particular species or variety can be increased. The U.S. Botanic Garden Staff has prepared this sheet to explain how easily this can be accomplished.

Materials Required

1. Box or flat and plastic wrap
2. A small bag of vermiculite or peat moss to fill the box 1/4 of the way up and the same amount of sand (course grade of builder's sand, not beach sand)
3. A rooting hormone (available in plant shops)
4. A light source. Cuttings root quickly and easily when a fluorescent light unit is the only light source. If this is unavailable, a window will suffice.

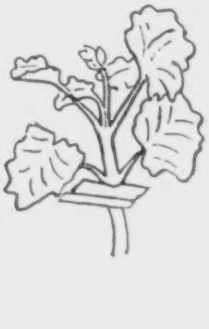
Preparing the Rooting Box

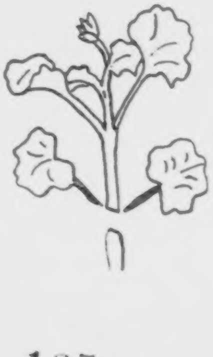
1. Fill the box halfway to the top with vermiculite or a 50-50 combination of peat moss and sand which have been thoroughly mixed together.
2. Pour enough water over the medium to make it evenly moist but not soggy. Do not allow the water to rise above the top layer of the medium.
3. Firm the medium down well with the palm of your hand.
4. Make a few air holes in the lid of the box with a hot nail.

Preparing the Cuttings

Cutting material should not be taken from very soft new growth. It should come from growth which will almost snap when bent. Do not take cuttings from a flowering shoot. If you are propagating a geranium or other flowering plant, take the cuttings from a nonblossoming side shoot. It is best to take cuttings from actively growing plants.

1. Always make the cuts at a node, the point where a leaf is attached to the stem. It is in the area of the node that roots form most easily. The cuttings should be about 3 to 5 inches long.
2. Gently pinch off the lowest few leaves on the cuttings, and wet the bottom inch or so of the bare stems.
3. Dip the wet stems in the rooting powder.
4. Make holes in the rooting medium with a pencil and place the base of the cuttings in the holes. Firm the medium well around the base of the cuttings so that they will stand on their own. (Most growers insert the bottom inch or two of the cuttings into the vermiculite or peat moss/sand mixture.)





APPENDIX: TIP CUTTINGS (Continued)

5. When all the cuttings have been taken, cover with plastic wrap, punch holes in it, and place the box about 6 inches below a fluorescent light unit or in front of a window. Since fluorescent tubes do not produce much heat there is not a problem with heat build up inside the box. This is not the case in front of a window. Thus, if a fluorescent light unit is unavailable place the box in front of a window which is bright but does not receive direct sunlight.

It will probably be unnecessary to add water to the box at any time since the high humidity inside usually prevents the rooting medium from drying out.

Occasionally, cuttings are too tall to fit inside the propagating box. If so, leave the lid off the box and place small bamboo stakes around the inside of the box. Then, drape plastic over the stakes. Tape the plastic to the sides of the box and make a few air holes in the plastic.

Planting the Cuttings

1. After a few weeks open the box and gently pull on the cuttings to see if they have rooted. If not, put the lid back on the box and check again a week later.
2. Plants which have rooted must be adjusted to the new environment outside the box. To do this remove the lid for an hour or so the first day, 2 or 3 hours the second day, and so on until the lid can remain off all day without the newly rooted plants wilting.
3. Prepare the soil into which the cuttings will be planted. If the appropriate soil mix is unknown, check in a house plant dictionary for recommendations.
4. Fill a 3 inch pot 3/4's of the way up with the soil mix. Firmly tap the pot against a table to eliminate any air pockets in the soil.
5. Gently lift the rooted cutting out of the box being careful not to disturb the new roots any more than is necessary.
6. Carefully spread the roots over the soil in the pot and cover them with additional soil. Firmly tap the pot against the table to be sure the soil makes good contact with the new roots.
7. Immediately water the new plant thoroughly with tepid water.

Care After Planting

Keep the humidity high around the newly planted cuttings and keep the cuttings out of direct sunlight for a few weeks. By doing so, transpiration, the process by which water is given off by the leaves, is reduced. This is important because the plants cannot afford to lose water through their leaves until their roots are functioning properly in the new soil.

An ideal way to increase humidity is by placing the plants on water-tight trays filled with small damp pebbles. Keep the pebbles moist by filling the trays with water up to the bottom layer of pebbles. Do not fill the tray up to the point where the pots are sitting in water. The water will evaporate and moisten the air surrounding the plant.

A few of the many plants which can be propagated by the above method

Abutilon
African violet leaves
Calathea
Chrysanthemum
Christmas cactus
Coleus
Croton
English ivy
Fuchsia
Geraniums
German ivy
Grape ivy
Hoya
Impatiens
Jade plant
Kalanchoe
Lantana
Maranta
Peperomia
Philodendron
Pilea
Pothos
Spider plant runners
Swedish ivy
Wandering Jew

Plant Culture Sheet 12A
Prepared by the U.S. Botanic Garden Staff
U.S. Government Printing Office: 1984 O 35-571

Written: 7/76
Updated: 8/79

APPENDIX: REPRODUCING PLANTS

Sexual reproduction in plants involves pollenation and fertilization. Often the pollen comes from a different flower than the one in which fertilization takes place (cross-pollenation). The resulting plant is then different from each of its parents.

In asexual reproduction there is but one parent and the offspring are genetically identical to that parent. All of the plants that are asexually derived from a single parent are called a clone.

Asexual reproduction is desirable when you have a marketable product, such as a desirably colored flower, and you do not want to risk changing the color. Sexual reproduction might result in a changed color.

Several means of asexual reproduction are runners, tubers, layering, grafting, slipping, and cloning plants from single cells.

Plants that are routinely propagated by asexual means are white potatoes (tubers), strawberries (runners), geraniums (slips), cane fruits such as blackberries (layering), apples (grafting), and orchids (cloning from single cell).

Cloning, as used in plant propagation, is the technique of taking small pieces of plant tissue (explants) and manipulating their chemical and hormonal environments so that many of the individual cells regain their ability to act as an embryo and give rise to an entire plant. This allows thousands of new plants to be produced from a single parent tissue. It is being routinely done with white potatoes, orchids, tobacco, and petunia. It is being expanded into areas wherever it is biologically possible and economically feasible.

APPENDIX: AIR LAYERING

In air layering, roots form on an aerial branch of a plant while it is still attached to the parent plant. The major benefit of this method of propagation is that the "cutting" is supplied with water and minerals by the parent plant during the rooting process. Thus, there is very little danger that the branch will die before roots are formed, which is often the case with regular cuttings.

Greenhouse plants should be air layered during a period of growth after 3 or 4 new leaves have been formed. Remember that the end of the branch will continue to grow during the rooting process so that the branch will be considerably longer by the time it is ready to be cut from the parent plant.

Materials Needed:

Sharp knife
Root-promoting substance
Sphagnum moss (about two handfuls)
Polyethylene film (about 8" x 10")
Waterproof adhesive tape

APPENDIX: AIR LAYERING (Continued)

PROCEDURE:

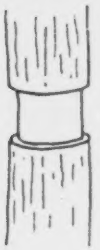
Girdle or slit the branch 6 to 12 inches from the tip end. To girdle: remove a strip of bark 1/2 to 1 inch wide around the entire branch. To slit: make a slanting cut about 3/4 of the way through the branch. The cut surfaces must be kept apart or they will grow back together and no rooting will occur. Prop the cut surfaces apart with sphagnum moss or a small piece of wood.

Dust the exposed areas of the slit or girdle with a root-promoting substance. Use a light coating; a heavy application will retard instead of stimulate the formation of roots.

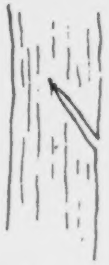
Soak the sphagnum moss in water, then squeeze out all of the excess moisture. If the sphagnum is too damp, the wood of the branch will rot. Place the moss around the branch to enclose the cut surfaces. Wrap in plastic and seal with tape.

Make sure that direct sun will never fall on the plastic film. This would raise the temperature inside the ball to such a high degree that root formation could not take place and those already formed would be severely damaged.

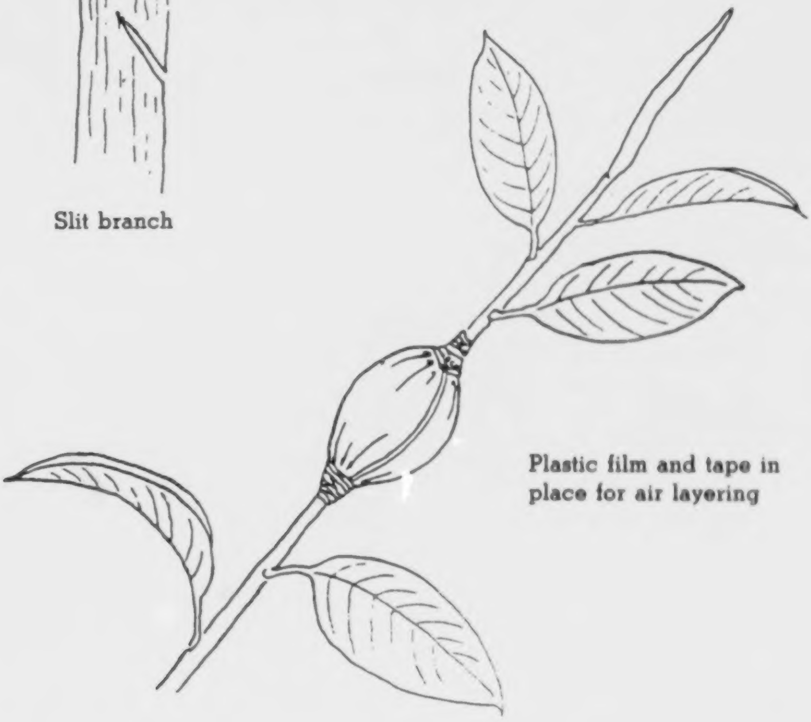
Roots are usually formed within two or three months. Do not remove the plastic covering and the moss to check on the growth of the roots — they can easily be seen through the plastic when they are large enough.



Girdled branch



Slit branch



Plastic film and tape in place for air layering

INTRODUCTION TO TECHNOLOGY TECHNOLOGY LEARNING ACTIVITY

SIMULATIONS AND MODELING

MODULE NUMBER: T-3
NUMBER OF DAYS: 15-20

MAJOR CONCEPTS TO BE ADDRESSED

T-3A There are formalized methods (systems) used to solve technological problems or make technological decisions.

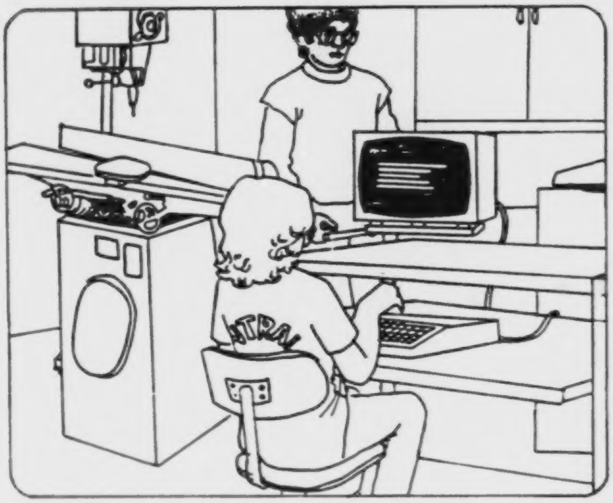
T-3B The problem-solving process includes design (planning) and implementation.

T-3C An important part of the problem-solving process involves the generation of alternatives and the search for optimal solution(s).

T-3D Optimization of a solution normally requires tradeoffs in order to best meet the specified design criteria.

T-3E Modeling techniques (see definition in syllabus glossary) are useful problem-solving aids.

T-3F Some problems cannot be solved by technology because of constraints imposed by the scientific principles, resource limitations, and constraints resulting from people's values and attitudes.



OVERVIEW OF TLA

By using a formalized problem-solving "system," students will gain a greater understanding of the methods used to solve problems. Students will design solutions for computer simulation problems. Formal problem solving will also be presented through the use of various kits such as Lego, Erector, Fischertechnik, Robotix, etc. Optimization, constraints, and limitations will be covered in the modeling activities.

EQUIPMENT AND SUPPLIES

- Computer
- Computer programs: The Factory, Gears
- Modeling activity kit such as Lego® Technic or Fischertechnik

PROCEDURE FOR THIS ACTIVITY

Days	POs*	Teacher Activity	POs*	Student Activity
1		Introduce problem solving with available programs (The Factory, Gears, etc.).	1b 1c	Solve sample problems without the use of the computer. Place work in notebook.
1	1d	Discuss advantages of computer aided problem solving. Demonstrate the program.	1d	Proceed through all levels of the computer program in sequence by the end of the Mod.

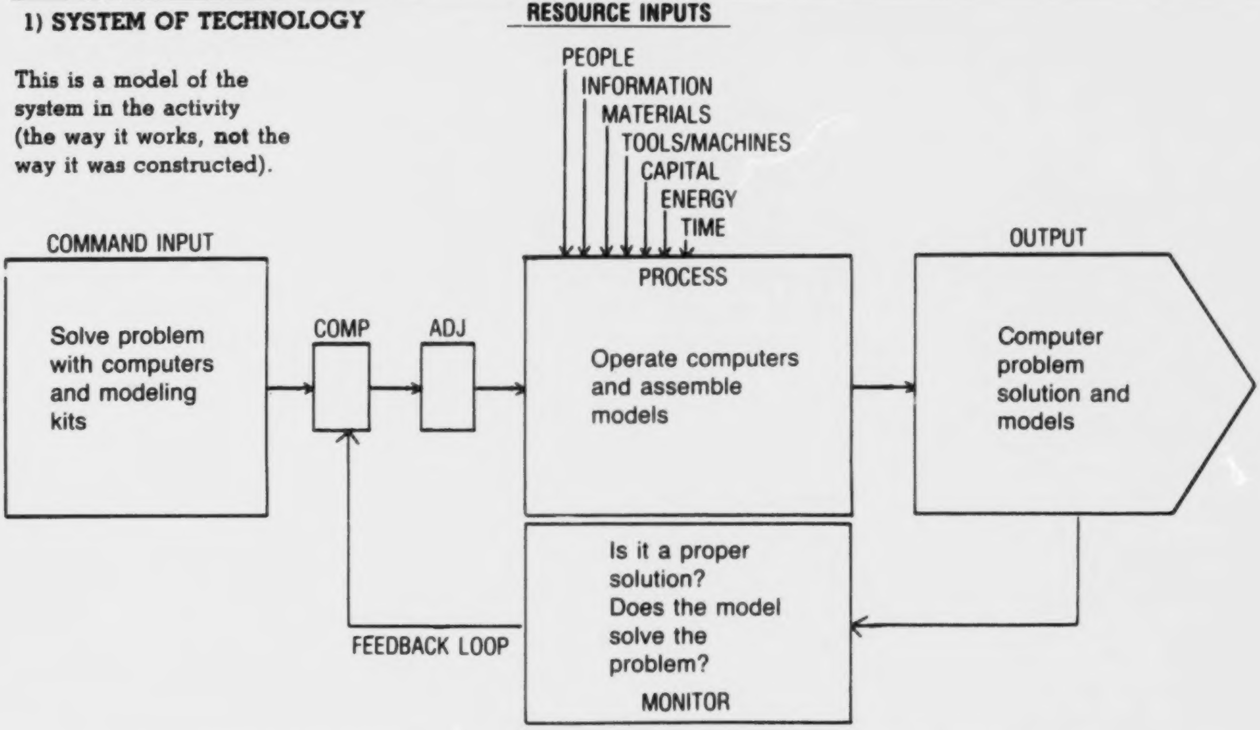
Days	POs*	Teacher Activity	POs*	Student Activity
1	1a	Discuss formal problem-solving steps and flowchart. Define terms.	1a 1c	Fill in flowchart with terms.
1		Act as a resource. Give students flowchart similar to the one in the Syllabus.	1a 1c	Fill in problem-solving flowchart with problems solved from previous Modules and above computer aided problem. Place work in notebook.
2	PO1	Introduce problem of motion and gears with Lego or similar kits. Discuss concepts of basic laws of motion, force, work, power, and energy. Identify constraints and limitations imposed by the 7 resources.	PO1 2a 2b 2c	Fill in problem-solving chart while working out solution. Identify 7 resources, scientific principles, limitations, and constraints that will affect the solution.
7-12		Monitor classroom problem-solving activities.	PO1	Solve problems with computers, Legos, kits, tools/machines, and available lab materials.
1	PO2	Relate models built with kits to technical problems in society. Assign problems in the 3 aspects of technology.	PO2	Identify constraints, resource limitations, values, and scientific principles for the 3 assigned problems.
1		Review activity and Syllabus content.		Take test on the activity learning, the Syllabus performance objectives, and the skills used in the activity.
15-20 Total Days				

*See Syllabus for phrasing of performance objectives and supporting competencies.

CONSTANTS FOR INFUSION INTO THE TLA

1) SYSTEM OF TECHNOLOGY

This is a model of the system in the activity (the way it works, not the way it was constructed).


RESOURCE INPUTS
PEOPLE
INFORMATION
MATERIALS
TOOLS/MACHINES
CAPITAL
ENERGY
TIME
COMMAND INPUT
Solve problem with computers and modeling kits
COMP
ADJ
PROCESS
Operate computers and assemble models
OUTPUT
Computer problem solution and models
Is it a proper solution? Does the model solve the problem?
MONITOR
FEEDBACK LOOP

IDENTIFY THE ROLE OF THE FOLLOWING RESOURCES IN THE SYSTEM ABOVE:
PEOPLE, INFORMATION, MATERIALS, TOOLS & MACHINES, CAPITAL, ENERGY, TIME

---

2) MATH - Angle measurement of 45, 90, 135, 180 degrees, rotation through various angles. Gear Revolution Calculations: division of decimals; rounding to tenths; substitution in a formula to find the missing variable. (Mention can be made of multigeared bicycles where students can compare ratio of teeth on pedal gear to teeth on wheel gear.

3) SCIENCE - Machines transfer energy from one point in space to another. Simple machines include the lever, wheel and axle, pulley, inclined plane, wedge, and screw. The pulley, wheel and axle, and gears are modified levers. Machines do not decrease work. They may: (1) change the direction of the applied force; (2) multiply force; (3) multiply distance; (4) multiply speed.

4) HUMAN & SOCIAL IMPACTS - Computers can provide high levels of accuracy and reliability. Through the use of modeling techniques, production quality has improved. Efficiency has increased by modeling solutions as opposed to actual fabrication and testing. A study of the early factory system in the United States illustrates that it had a tremendous impact upon the lives of the people who worked in these plants. After reviewing this, students should be asked to look at our modern industries and describe some of the current and potential long-range effects of our methods of production on individuals and society.

5) COMMUNICATION SKILLS - Familiarity with keyboard. Simulation with visualization is easier to show and discuss with others. Simulation can be used in many other situations.

6) SAFETY AND HEALTH - Simulation eliminates real hazards (noise, injury, dust) during testing and training. Care of hardware and software must be observed.

7) PSYCHOMOTOR SKILLS - Visualization allows for mental images to be compared with actual outcomes. 3D movement may differ when presented in 2D format.

8) CAREER RELATED - Work with up-to-date equipment, as in present engineering, R&D, and production organizations.

9) CREATIVE PROBLEM SOLVING - Opportunities for creative problem solving will be provided by this TLA including: identification and definition of a problem, goal and criteria setting, generation of alternative solutions and recognition of limitations, optimization, testing, and evaluation.

10) TRANSFER OF LEARNING - Use of simulation to model technological solutions to medical problems. Flight training with simulator.

BACKGROUND REFERENCES AND RESOURCES

THE FACTORY and *GEARS,* by Sunburst (Educational Materials Supplier), 38 Washington Avenue, Pleasantville, NY 10570

Lego Technic Teachers Guide I & II

EVALUATION

The teacher should develop a two component evaluation system to determine if the student understands: (1) performance objectives and (2) skills, attitudes, knowledge & safety related to the specific lab activity.

(1) EVALUATION OF PERFORMANCE OBJECTIVES (Examples)

1. Each student will identify a problem encountered in everyday life. S/he will then fill in a formalized problem solving flowchart for the solution of the problem. PO-1

2. Given a blank flowchart of the problem solving system (see Syllabus), the student will fill in the steps involved in problem solving. 1a

3. Identify common limitations imposed by the 7 resources. 2-b,c

4. Give examples of scientific principles that are encountered in everyday living (ex. force, motion, work, kinetic theory, thermal, sound; see physics book). 2a

5. Create a matching test for the enabling vocabulary.

6. Give a short answer test with questions drawn from the performance objectives and supporting competencies.

7. Give the students a common problem in one or more of the aspects of technology. Have the students identify the constraints and classify them. PO-2.

(2) EVALUATION OF SKILLS, ATTITUDES, KNOWLEDGE & SAFETY (Examples)

1. Students must reconstruct the sequence of machines and processes used to create a given product.

2. Students must assemble a series of gears so the direction and number of revolutions of the last gear match the given problem. Satisfactory construction of modeling problem.

APPENDIX: THE FACTORY (Computer Program)

The Factory has three activities or subprograms: Test A Machine, Make A Product, and Build A Factory.

Preparation:

Before using the program with students, the teacher may want to discuss the mathematical concept of rotation: What does it mean to rotate an object 45 degrees? 90 degrees? 135 degrees? The concept of rotation could also be left for the students to discover in the subprogram, Test A Machine.

Using the Program:

All students should first select the Test A Machine activity and be familiar with how the machines work. The students can then proceed to activities 2 and 3 to create products. The Factory Product Sheet can be used to record the products made and the machines used. Some variations that have been used in the classroom include:

APPENDIX: THE FACTORY (Continued)

My Product - Using the Factory Product Sheet, students design their own product on paper and then try to produce it with THE FACTORY. Interesting designs, such as a star, can be formed by punching one square, rotating 45 degrees, and punching another square.

Product Efficiency - Using Make A Product, students try to outdo one another by creating the given product in the fewest steps. A random product will be created by the computer. Player 1 tries to make that product. If successful, the same product is selected again and Player 2 tries to make it in fewer steps.

Another variation on this is to challenge both students to make the product in a given number of steps. For example, you can tell the students to use five steps to make a particular product. In the case of a very simple problem, students will discover how to use rotation and other processes which will not be evident in the final product.

I'm In Charge - One student (supervisor) determines what the product will look like by drawing it on the Factory Product Sheet or creating it using activity 2 - Make A Product. The second student worker tries to duplicate the first's product using the Build A Factory activity. If the worker fails, the supervisor gets a chance. If the supervisor cannot produce it either, the two exchange roles.

APPENDIX: GEARS (Computer Program)

Introducing Students to Gears

Begin introducing the program to your students by giving them a short overview of the history of the gears:

Gears first appeared over two thousand years ago. They were originally developed as a leverage device that allowed people to lift or push heavy logs. The most common use of early gears was to draw water from deep wells.

Later, larger gears were made so that animals could draw up the water. As time went on, gears were used with windmills and water wheels to grind grain into flour.

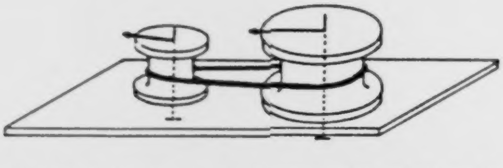
The worm-type gear was developed by Archimedes in Greece to drive other gears. Leonardo da Vinci was another famous historical figure who understood and made innovative use of the intriguing property of gears. Students could be given an assignment to write a report on one of these men.

Today, gears are used in many everyday objects. Non-digital watches and clocks make extensive use of gears. Bicycles use gears: they can make your pedaling very easy when you go up a hill or they can make you go very fast when you come back down. A car is full of gears. Even television dials work with gears.

Next, you may want to give a classroom demonstration of some common objects or tools that use gears. Some suggestions:

- an egg beater
- a pencil sharpener
- a toy train
- a can opener
- record player 33rpm/45rpm/78rpm
- dissect an old clock or watch

Students might also look at the movement of "pulleys." Two different sized spools of thread with rubberbands connecting them could be experimented with as shown below.



With a pointer marked on each spool, the students could discover the relationship of the rotations of the two pulleys. Then as they begin to work with meshed gears, they will discover the basic difference between pulleys and meshed gears is a change of direction.

APPENDIX: GEARS (Continued)

Classroom Use of Build a Gear Train (Computer Program)

The easiest concept for beginners to understand is the direction of the rotation of meshed gears. Using the **Build A Gear Train**, the students begin by working with as many combination of gears as possible. The types of gears used are not important at first, but the rotation of the last gear should be noted along with the number of gears used. After a short time experimenting and predicting, they should be able to state the relationship listed on page 13 of the software documentation. After the students are comfortable with the direction of rotation, hand out the Rotation Worksheet (page 23) as a follow-up.

Next, have the students discover the relationship gears of different sizes have on each other. Using the Gear Ratio Worksheet (page 24) will help students keep track of the revolutions in every two-meshed gear combination. Since most of the combinations have decimal answers and are derived from a formula using division, students should have worked with division of decimals and rounding to the tenths place prior to doing this section.

Students should fill in the Ratio Worksheet. As they work with more than two gears, they soon discover that the number of gears changes **only** the direction; the number of rotations is dependent only on the first and last gears. From their notes they should also begin to see the relationships between the number of rotations and the number of teeth.

As they become more familiar with how the gears work, they may use the challenger part of **Build A Gear Train** to challenge a friend to duplicate the number of rotations made by the last gear. At this point, if they haven't done so already, they should be told to derive a formula for the gear rotations. Many students may derive the formula on their own, but others may need a little extra guidance.

Classroom Use of Solve A Gear Puzzle (Computer Program)

Even though it is helpful, it is not necessary for students to find the formula for gear rotation in order to proceed to the second level. Many students may need this level to motivate them. In Level Two there are easy and hard problems. On the easy problems, the number of revolutions of the first gear is always 10. On the hard problems, the students may, after putting the gears together, choose to have from 1 to 30 revolutions for the first gear. Students should stay on the easy level until they see the relationships and derive the formula.

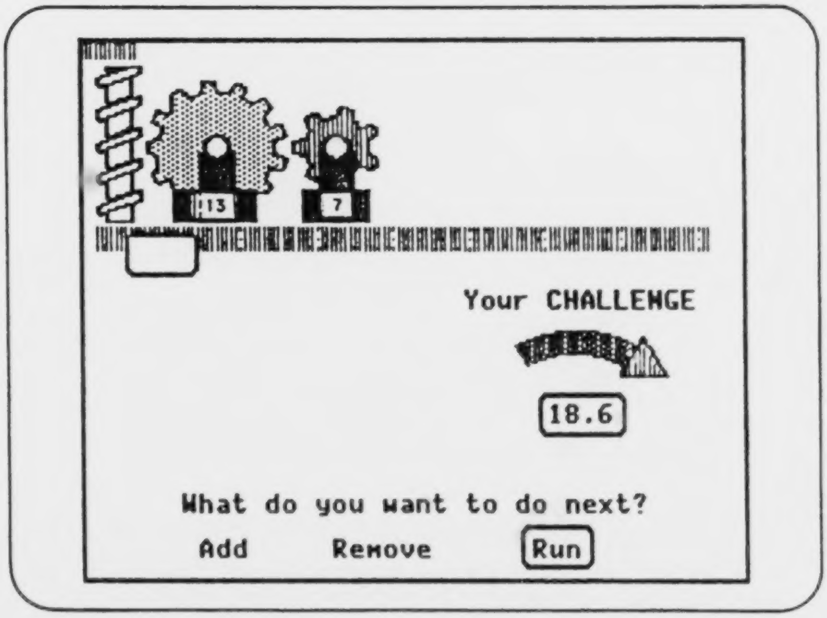
As students begin to use the formula:

$$\text{Revolutions of last gear} = \frac{\text{\# of teeth of first gear x revolution of first gear}}{\text{\# of teeth of last gear}}$$

students should be reminded that this is a good place to practice their rounding skills. The number of revolutions is rounded to the tenths place.

APPENDIX: GEARS (Continued)

An easy problem could be similar to the one below. Students know the first gear will rotate 10 times and must make the last gear rotate 18.6 times:



The solution could have had 2 or 4 gears to achieve the clockwise directions. Students could use the formula or the Ratio Worksheet to form their conclusions as to which gears to use.

Classroom Use of Build A Gear Factory (Computer Program)

Students should be able to compare this level of GEARS to word problems since they are **asked** to Build A Gear Factory to fill an order for a certain number of items.

A truck driver will arrive at the student's factory to place an order. The students must know the gear rules to produce the correct number and type of production on the order. Some drivers want computer monitors and others want printers. Some orders are large and some are small.

The direction of the last gear determines which product is produced. Each time it rotates one complete clockwise rotation, a monitor is produced; counter-clockwise and a printer is produced. Since the factory cannot produce a part of a product, the students must calculate their answer to the largest whole number (integer value). For example, if the first gear is an 11-tooth gear rotating 10 times and the last a 7-tooth gear, then the last gear would rotate (11 x 10)/7 or 15.7 times. Since fractional products can't be produced, Level 3 would produce 15 products. As in **Solve A Gear Puzzle,** the hard problems of this section will cause the student to check out a large number of combinations before reaching the result.

INTRODUCTION TO TECHNOLOGY
TECHNOLOGY LEARNING ACTIVITY

BASIC SECURITY/ DETECTION SYSTEMS

MODULE NUMBER: T-4
NUMBER OF DAYS: 20-25

MAJOR CONCEPTS TO BE ADDRESSED

T-4A New technologies often evolve as a result of combining existing technologies (confluence of systems).

T-4B A technological system is one through which a technological process combines resources to provide an output in response to a command input.

T-4C People design systems to satisfy their needs and wants.

T-4D The basic systems model can be used as a tool to analyze systems in each of the three aspects of technology.

T-4E When two or more systems are combined to form a new system, the original systems become subsystems of the new system.

T-4F People combine subsystems in order to produce more powerful systems.

T-4G Open-loop systems are unable to adjust for changing conditions.

T-4H The addition of feedback to open-loop systems provides an increased measure of control to the resulting closed-loop system.

OVERVIEW OF TLA

The teacher, through the use of basic security/detection devices, will instruct the student in how to recognize systems and subsystems in each of the three aspects of technology. In doing so the student will be able to identify the components of a system, distinguish between open- and closed-loop systems, and distinguish between systems and subsystems. This will be accomplished by fabricating various security/detection systems which will monitor high water, temperature, fire, intrusion, and light intensity. Through the use of systems with feedback, students will understand technology through the analysis and practical applications of systems theory.

EQUIPMENT AND SUPPLIES

- Various pieces of hardware and electrical supplies

- See illustrations and schematic diagrams at the end of this TLA for specific equipment and supply applications.

PROCEDURE FOR THIS ACTIVITY

Days	POs*	Teacher Activity	POs*	Student Activity
1	1a 1b	Identify the components of a system and illustrate them in a block diagram form indicating how the systems are linked.	1a 1b	Draw a block diagram of the systems model and identify the components of each system.

Days	POs*	Teacher Activity	POs*	Student Activity
	1c PO1	Give an illustration of a system in each aspect of technology and describe how monitoring and feedback loops control the system.	1c PO1	For homework, identify a system in the home, diagram that system via the block diagram, and indicate how that system incorporates monitoring and feedback controls. Long-range homework: keep a notebook of newspaper and magazine articles that give examples of technological systems that are biologically related, information/communication, or physical technologies. Analyze the articles and illustrate the technologies in a systems block diagram.
2-3		Have students identify situations where security/detection systems can be applied in the home.		List examples where security/detection systems can be used in the home.
	3a	Discuss open- and closed-loop systems.	3a	In teams of 2-3 members, brainstorm a list of open-loop systems.
	3b	Demonstrate using a mechanical timer to turn on a light — open loop. (See appendix for other examples of open-loop systems.)	2a	Using systems diagrams, complete one open-loop diagram from the brainstormed list.
1	3a	Introduce closed-loop systems with feedback. Examples: home heating systems and ovens; metal detector; grocery store conveyor which is light controlled.	3a	From the list, select one open-loop system, introduce feedback loop, and complete closed-loop systems.
2-3		Present illustrations of circuit diagrams and electrical systems.		Identify schematic and pictorial representations for: conductors, connectors, switch battery, bulbs, etc.
	2c 3d	Identify, describe, and demonstrate series circuits necessary to fabricate a security/detection system.		Categorize a given circuit as series or parallel.
			2b	In groups, begin fabrication and testing security/detection systems.
10-12		Divide class into activity groups. Assign each group a specific security/detection system to fabricate.	2c 3d	Produce a goal/criterion statement (design brief); generate alternative solutions.
		Following completion of this system direct students to move on to the fabrication of additional security/detection systems.	PO2 3b 3c	After completion of the security/detection system, test system, monitor actual results, and compare to desired results.
				Adjust system to its optimal satisfactory performance.
1	3a	Lead students in group discussion of models.	3a	Evaluate the device.
			PO3	Classify security/detection systems that were constructed as open- or closed-loop systems.
				Add feedback to close open systems.
1	4a	Describe what the subsystems of a system are.	4a	Analyze security/detection devices to differentiate between the system and the subsystems of the device.

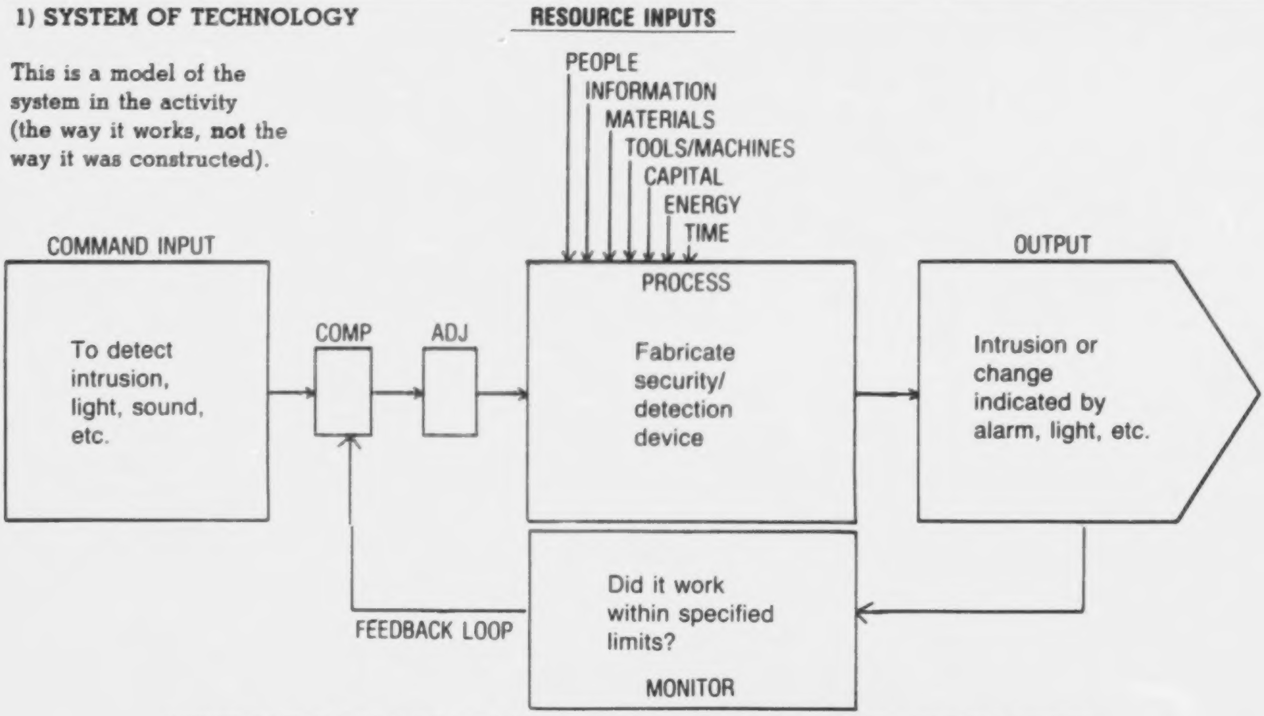
Days	POs*	Teacher Activity	POs*	Student Activity
			4b 4c	Utilize systems diagrams to analyze and identify subsystems within the system.
1-2	4b	Give an example of a modern system from each of the three aspects of technology.	PO4	From the long-range homework assignment, give an example of a modern, complex technological system from each of the three aspects of technology.
	4c PO4	Lead a discussion of the subsystems and their impact on the system. Monitor discussion.	PO4	Identify the subsystems and explain how they have been combined to generate a new system, resulting in improved or additional human capabilities.
1		Give test on Module 4.		Take test on Module 4.
20-25 Total Days				

*See Syllabus for phrasing of performance objectives and supporting competencies.

CONSTANTS FOR INFUSION INTO THE TLA

1) SYSTEM OF TECHNOLOGY

This is a model of the system in the activity (the way it works, not the way it was constructed).


RESOURCE INPUTS
PEOPLE
INFORMATION
MATERIALS
TOOLS/MACHINES
CAPITAL
ENERGY
TIME
COMMAND INPUT
To detect intrusion, light, sound, etc.
COMP
ADJ
PROCESS
Fabricate security/ detection device
OUTPUT
Intrusion or change indicated by alarm, light, etc.
FEEDBACK LOOP
Did it work within specified limits?
MONITOR

IDENTIFY THE ROLE OF THE FOLLOWING RESOURCES IN THE SYSTEM ABOVE:
PEOPLE, INFORMATION, MATERIALS, TOOLS & MACHINES, CAPITAL, ENERGY, TIME

2) **MATH** - Calculation of the cost of the systems fabricated. Calculate force and pressure necessary to activate sensors. Analyze statistical data and draw a graph relating insurance costs to crime/disaster frequency; tolerance and range. See Appendix: Math Concepts.

3) **SCIENCE** - Electron flow, Ohm's law, series, parallel circuits, insulators, and conductors. See Appendix: Science Concepts. Use of multimeter to measure voltage, resistance and current in the circuit, resistance color coding, metric units, and electronic symbols.

4) **HUMAN & SOCIAL IMPACTS** - Less expensive and more effective use of electrical energy and human energy. Aids in reduction of crime, property loss, smoke/fire damage, and water damage.

5) **COMMUNICATION SKILLS** - Diagram input, process, output of open system. Diagram closed system with feedback. Students will understand that schematic diagrams are used to explain electrical circuits information. Identify symbols used for electrical components in the schematic diagram.

6) **SAFETY AND HEALTH** - Safe use of electricity. Safe use of tools. Safe use of acid. Proper use of eye protection.

7) **PSYCHOMOTOR SKILLS** - Students will develop or improve eye-hand coordination and manual dexterity by tracing patterns and cutting along lines.

8) **CAREER RELATED** - Careers in electricity, electronics, assembly, design, installation, and police science.

9) **CREATIVE PROBLEM SOLVING** - Opportunities for creative problem solving will be provided by this TLA including: identification and definition of a problem, goal and criteria setting, generation of alternative solutions and recognition of limitations, optimization, testing, and evaluation.

10) **TRANSFER OF LEARNING** - Students will be able to identify natural and human made systems and classify them according to open and closed loop.

BACKGROUND REFERENCES AND RESOURCES

McGraw-Hill Encyclopedia of Science and Technology

Goodheart-Wilcox: Basic tests in various areas

Barber, Alfred W. *Experimental Guide to Solid State Electronic Projects*. West Nyack, New York: Parker Publishing, 1980

SCR Manual, 1979. General Electric, Semi-Conductor Products Department, West Genesee Street, Auburn, New York 13021.

Oliva, Ralph A. and Charles W. Dale. *D.C. Circuits Vol. 1*. Basic Electricity and Circuit Concepts. Texas Instruments Learning Center. Radio Shack, Fort Worth, Texas 76102.

Solid State Circuits. Radio Shack, Fort Worth, Texas 76102.

A.C. Circuits. Basic Electricity and Circuit Concepts. Radio Shack, Fort Worth, Texas 76102.

Science Fair "50 in 1" Electronic Kit, 1976 Tandy Corporation, Fort Worth, Texas 76102.

Electronic Parts Catalogs:

Radio Shack Catalog, Tandy Corportion, Fort Worth, Texas 76102

Jameco Electronics Corp., 1355 Shoreway Road, Belmont California 94002

Solid State Sales, P.O. Box 74, Somerville, MA 02143

EVALUATION

The teacher should develop a two component evaluation system to determine if the student understands: (1) performance objectives and (2) skills, attitudes, knowledge & safety related to the specific lab activity.

(1) EVALUATION OF PERFORMANCE OBJECTIVES (Examples)

1. Identify the components of your device in systems terms. PO1, abc.

2. Is the system that was constructed cost effective? Does it satisfy human needs and wants? Does it affect the environment positively? PO3

3. Which of the following is an example of a closed-loop system? a) sprinkler for lawn with timer, b) smoke detector, c) vibration alarm, d) safety device on oil burner which turns off oil when there is a problem. 3a

4. From a list of five systems, students will be able to identify those which are closed or open loop. 3a

5. Using systems diagrams, explain the subsystems of one of the following technological systems. (Teacher supplied list) PO4

(2) EVALUATION OF SKILLS, ATTITUDES, KNOWLEDGE & SAFETY (Examples)

After the device is constructed and tested, the following questions will be answered.

1. Did the system function as designed?

2. What problems were discovered in the development of the device?

3. What modifications could be made to improve the system, e.g., accuracy, long life, reliability?

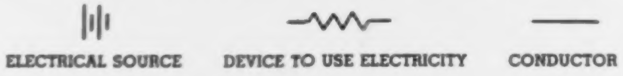
4. List the safety precautions that must be taken when using etching solution.

5. Explain the differences between a series and a parallel circuit.

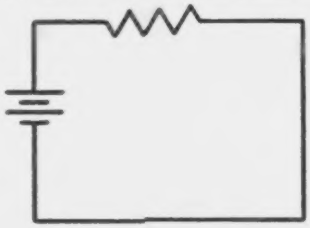
APPENDIX: MATH AND SCIENCE CONCEPTS AND OTHER RELATED MATERIAL

Science Concepts

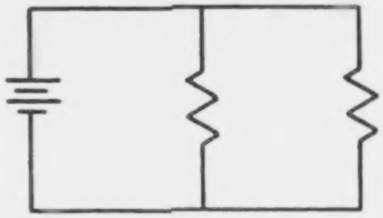
1. An electrical current is a flow of electrons through a conductor.
2. Conductors are materials that carry an electrical current.
3. Insulators are materials that will not allow an electrical current to pass through them.
4. For an electrical current to flow, there must be a complete electrical circuit.
5. The simplest complete electrical circuit consists of an electricity source, conductors to carry the electricity, and a device to use the electricity.
6. Many other devices may be part of an electrical circuit.
7. Electrical circuits are of two basic types: **series** and **parallel.** Symbols used in circuits are:



8. A series circuit consists of one path for the electrons to follow. The most simple series circuit is diagrammed as follows:



9. A parallel circuit consists of two or more paths for electrons to follow. The most simple parallel circuit is diagrammed as follows:



APPENDIX: MATH AND SCIENCE CONCEPTS (Continued)

10. In order to construct electrical circuits properly, it is necessary to measure various characteristics of electrical currents.

11. The amount of electricity flowing through a circuit is measured in units called amperes, often abbreviated amps. Its symbol is **I.**

12. The amount of work done in moving electrons through a circuit is measured in a unit called the volt. Its symbol is **E.**

13. When an electrical current flows through a circuit, it encounters a force called resistance, which hinders the flow of electrons. This quantity is measured in a unit called ohms. Its symbol is the Greek letter omega, Ω or **R.**

14. When working with electrical circuits, the three quantities, amperes, volts and ohms, have been found to be related mathematically by a relationship called Ohm's law.

15. Ohm's law, stated mathematically is: $I = \frac{E}{R}$

Math Concepts

Excellent unit to have students analyze "stored data." They can:

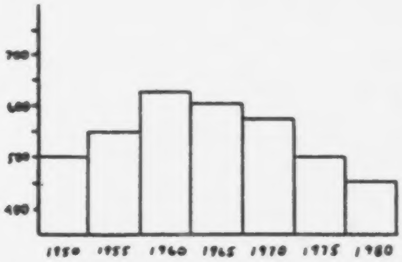
a. Gather data relating to their device (ex. fire detection system gathers statistics on fires in country or in an area: home, workplace, shopping center, etc.).

b. Organize information in a table and find the measures of central tendency which are **appropriate** to data.

1) mean (average)	-avg. # of fires per/day
2) median (middle-most score)	-2, 3, 3, 6, 7 median
3) mode (most frequently occurring)	-2, 3, 3, 6, 7 mode

c. Graph the data into frequency histogram (bar graph in which each bar represents equal interval).

Deaths in Home Due to Fire



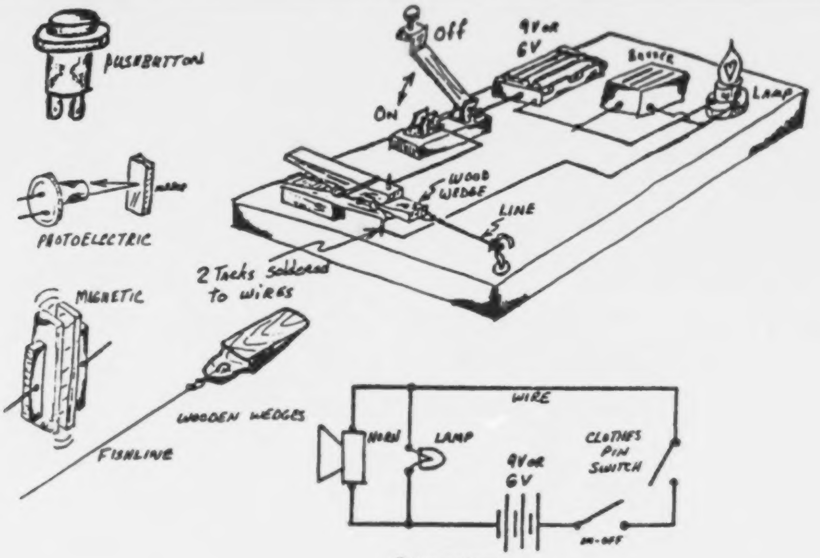
Data from 1984 **World Almanac**

(Students need not start graph from zero, but must have equal units on axis.)

d. Predict about future based on findings.

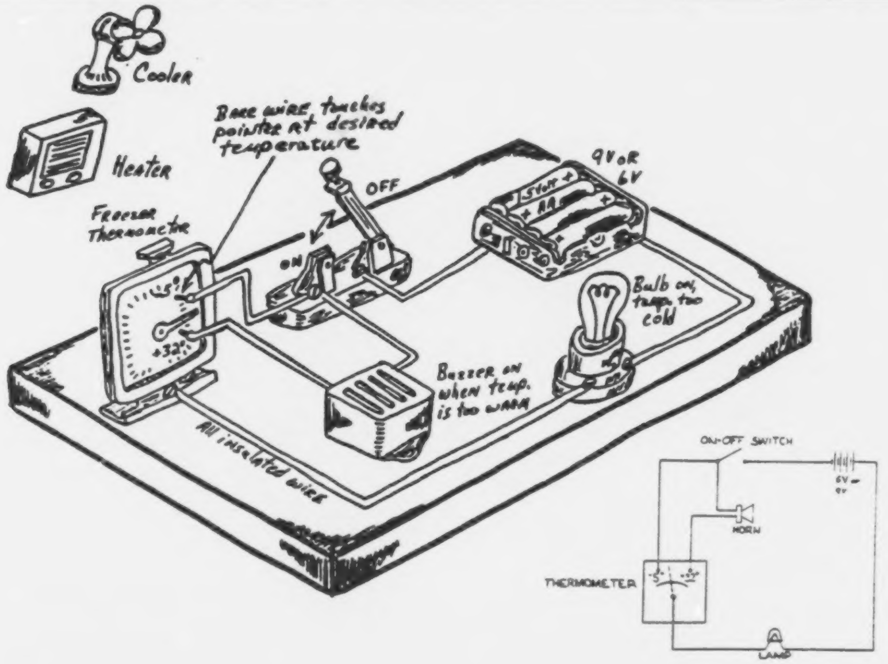
If time permits, students could conduct a survey (in class/or in area) of homes that have fire/security devices, etc.

APPENDIX: CLOTHESPIN ALARM SYSTEM

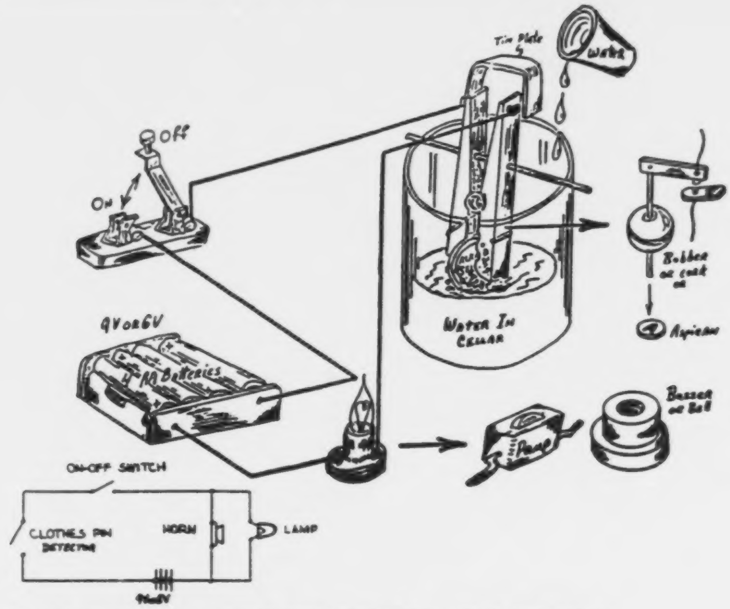

PUSHBUTTON
PHOTOELECTRIC
MAGNETIC
off
ON
9V or 6V
BUZZER
LAMP
WOOD WEDGE
LINE
2 Tacks soldered to wires
WOODEN WEDGES
FISHLINE
WIRE
HORN
LAMP
9V or 6V
CLOTHES PIN SWITCH
ON-OFF

SCHEMATIC

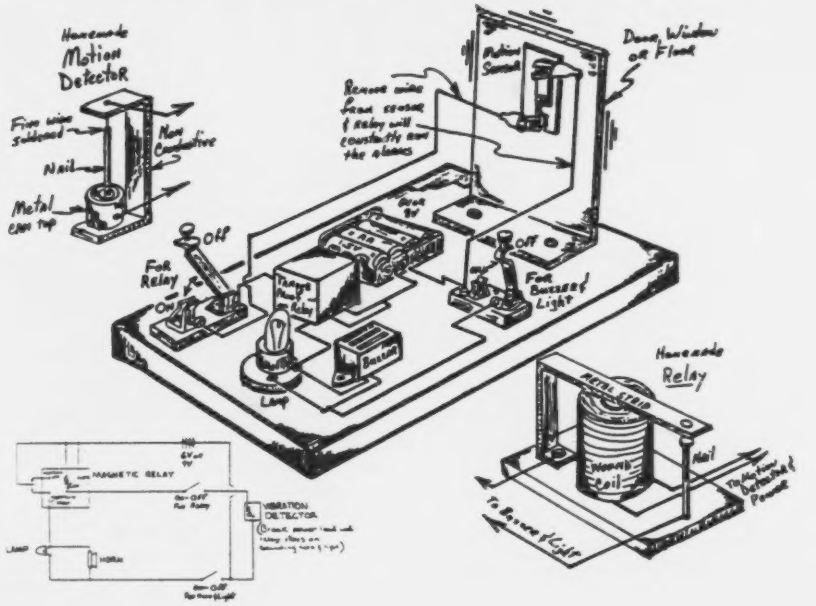
APPENDIX: ENERGY/FOOD SAVER


Cooler
Heater
Freezer Thermometer
Bare wire touches pointer at desired temperature
OFF
ON
9V or 6V
5 Volt
AA
Bulb on, temp. too cold
Buzzer on when temp. is too warm
All insulated wire
+32°
ON-OFF SWITCH
6V
9V
HORN
THERMOMETER
LAMP

APPENDIX: TOO MUCH WATER


Tin Plate
Water
Off
On
Bobber or cork
Water In Cellar
Airplane
9V or 6V
4 AA Batteries
Buzzer or Bell
Pump
ON-OFF SWITCH
CLOTHES PIN DETECTOR
HORN
LAMP
9V or 6V

APPENDIX: INTRUDER ALARM


Homemade Motion Detector
Fine wire soldered
Non Conductive
Nail
Metal can top
Motion Sensor
Door, Window or Floor
Remove wire from sensor & Relay will constantly run the alarms
6V or 9V
Off
For Relay
On
Off
For Buzzer & Light
Lamp
Buzzer
Homemade Relay
Metal Strip
Wound Coil
Nail
To Motion Detector & Power
To Buzzer & Light
6V or 9V
MAGNETIC RELAY
On-Off For Relay
VIBRATION DETECTOR
LAMP
HORN
On-Off For Horn & Light

INTRODUCTION TO TECHNOLOGY TECHNOLOGY LEARNING ACTIVITY

PRODUCTION SYSTEMS

MODULE NUMBER: T-4
NUMBER OF DAYS: 22

MAJOR CONCEPTS TO BE ADDRESSED

T-4A New technologies often evolve as a result of combining existing technologies (confluence of systems).

T-4B A technological system is one through which a technological process combines resources to provide an output in response to a command input.

T-4C People design systems to satisfy their needs and wants.

T-4D The basic systems model can be used as a tool to analyze systems in all of the aspects of technology.

T-4E When two or more systems are combined to form a new system, the original systems become subsystems of the new system.

T-4F People combine subsystems in order to produce more powerful systems.

T-4G Open-loop systems are unable to adjust for changing conditions.

T-4H The addition of feedback to open-loop systems provides an increased measure of control to the resulting closed-loop system.

OVERVIEW OF TLA

Students will produce a product through mass production and assembly line techniques. Students will discuss systems and develop the structure of a mass production manufacturing system and related subsystems. This TLA can be modified to accommodate a number of student produced products utilizing this basic format for mass production.

EQUIPMENT AND SUPPLIES

- Equipment and supplies available to accomplish the chosen mass production activity illustrating systems and subsystems involved in technological activities

PROCEDURE FOR THIS ACTIVITY

Days	POs*	Teacher Activity	POs*	Student Activity
1	1a 1b	Overview of mass production and examples of systems in the three aspects of technology. Use the human body for bio-related and income tax for information related examples. Use the computer for physical related information.	1a 1c	Discuss and answer questions on the 3 aspects of technology using block diagrams, demonstrating knowledge of the various blocks including monitoring and comparison. Show how they fit in and tie together.

Days	POs*	Teacher Activity	POs*	Student Activity
	2a	Give demos on lab equipment that might be used in research and development activities.	1b 2c	Draw and label the blocks in the systems model. Observe and have trial experiences in the safe operation and use of materials, tools, instruments, equipment and procedures.
1		Assign homework activity (for the month).	PO1	Develop a report on a system in each of the three aspects of technology. Memorize the block positions for input, process, output, feedback, control, etc.
		Announce that on the second day of this module, problem-solving activities will begin and students will be expected to apply the information and knowledge presented in the first class period.		Apply the complete systems diagram to individual cases in all three aspects of technology. Draw and explain a complete system from memory and show how the parts are linked together.
1	2a	Discuss materials, give demos with machines and materials (composites, plastics, metals, woods, etc. (Be sure to include packaging.)	2a	Identify the components of a system. Show where materials under discussion fit into the system.
		Relate discussions to all three aspects of technology - tie all three together. Teach transfer by using a wide variety of examples. Use common examples that most all would know as the first transfer activity. (Quiz and test for transfer.)	2b 2c	Test materials as part of the systems model. Evaluate, adjust, and modify materials as part of the system. Show how it modifies the system when materials are modified.
			2c	Use materials of all three aspects of technology.
	1b	Discuss research and development activities in all three aspects of technology. Discuss systems and subsystems of technology. Show by examples.	2b 2b	Test and evaluate various materials. Take turns at various testing stations to test, evaluate, and adjust materials as part of the system. Take notes and enter into logs the components of the system and subsystem.
1		Facilitate activity.	2b 2b 2c	Compare results of tests. Adjust systems materials and show how to adjust systems for maximum fit. Elect safety inspectors. Check for safety as a continuous process.
4	1, 2 & 3	Demonstrate hand tools and machines necessary for production. Discuss and relate to safety rules and procedures.	2c	After demonstration, use hand tools and machines with safety and under supervision.
1	PO1 PO2	Design of the products (e.g., school emblem).	PO2	Apply the technological systems model to the safe assembly or construction and operation of a system which encompasses physical technology in the production of the product.
11		Supervise students on machines for testing purposes.	3d 2c	Use materials, tools, instruments, equipment and procedures safely.

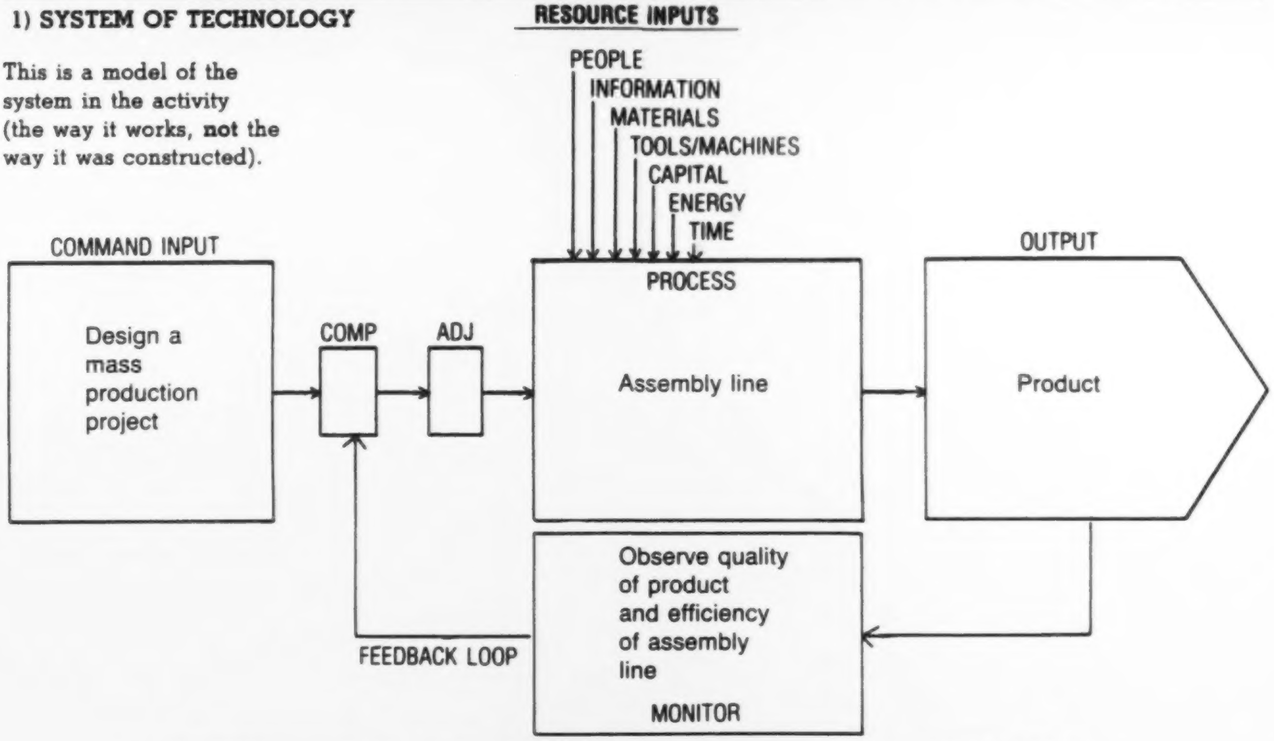
Days	POs*	Teacher Activity	POs*	Student Activity
1	1a	Systems diagrams - Use completed and blank diagrams, check all 3 aspects of technology.	1a 2a	Identify the components of a system in the creation of the product. "Walk through" production process identifying the components of the system.
1	1	Help set up product flowcharts and assembly line stations. Discuss procedures and assignments on line. Discuss strategy of operations including interweaving of the 3 aspects of technology. Show transfer from one aspect of technology to another. Show similarities and differences. Ask students to identify similar experiences in hypothetical production runs.	3a 2b 1c	Distinguish between open- and closed-loop systems in the production of the products. Test, evaluate, and modify the system. Describe the monitoring and feedback parts of the systems model as it pertains to the production of the product. (Description is provided by the student who will perform the job in production.)
1	2	Dry run of assembly line or process line. Always look for hidden transfer from one aspect of technology to another. Keep students conscientiously aware of transfer. Discuss eye safety.	2b 2c 3c	Try individual job. Determine what changes are needed. Modify system. Provide examples of how sight is used as a bio-related feedback system.
4		Observe production run. Time depends on quantities desired, difficulty of sessions, etc.	2c 3c PO3	Use materials, tools, machines, instruments, equipment and procedures in a safe manner. Rotation of jobs may be useful. Apply systems model to do work. Apply feedback, adjust the system.
2	4	Supervise review and summary. Emphasize transfer aspects. Show observed interrelatedness of the process.	2b,2c 3b 4a 4b 4c	Evaluate finished product. Show interrelatedness of aspects of technology. Tell of feedback and adjustments found necessary as jobs progressed. Identify which systems and subsystems were involved. Wall charts of systems diagrams are used.
			4a 4b 4c	Present reports on three aspects of technology. (Not all students complete all activities, but all must transfer the activities' interrelatedness.)
2	4	Prepare scenarios which require a technological solution to a problem. Include the 3 aspects of technology. Show how systems and subsystems can be combined and how the new systems generated can improve human capabilities or human conditions.	PO1 PO2 PO3 PO4	Model the systems and subsystems that solve the problems presented in the scenarios. Blank and partially completed systems diagrams are used.
22 Total Days				

*See Syllabus for phrasing of performance objectives and supporting competencies.

CONSTANTS FOR INFUSION INTO THE TLA

1) SYSTEM OF TECHNOLOGY

This is a model of the system in the activity (the way it works, **not** the way it was constructed).


RESOURCE INPUTS
PEOPLE
INFORMATION
MATERIALS
TOOLS/MACHINES
CAPITAL
ENERGY
TIME
COMMAND INPUT
Design a mass production project
COMP
ADJ
PROCESS
Assembly line
OUTPUT
Product
Observe quality of product and efficiency of assembly line
MONITOR
FEEDBACK LOOP

IDENTIFY THE ROLE OF THE FOLLOWING RESOURCES IN THE SYSTEM ABOVE:
PEOPLE, INFORMATION, MATERIALS, TOOLS & MACHINES, CAPITAL, ENERGY, TIME

2) MATH - Cost analysis of production. Graph of production time study. Measuring.

3) SCIENCE - Chemistry of plastics. Synthetics versus natural materials. Energy. Ecology and environmental impacts. Natural systems. Importance of accuracy in communication systems. Develop accuracy in weaker and weaker solutions of various products like soda, vinegar, salt, and sugar mixed in water to analyze systems and subsystems in bio-tech. Encourage experimentation.

4) HUMAN & SOCIAL IMPACTS - The introduction of mass production techniques into the manufacturing process generated many positive and negative consequences. Students should be asked to identify some of these and indicate how they are currently being dealt with by American industry. Where problems still exist, potential solutions should be explored.

5) COMMUNICATION SKILLS - Write technological reports related to mass production techniques and materials, safety, health, and other ideas. Vocabulary and technical terms. Set up oral and written reports and invite others to come in and judge and critique reports. Be professional in the various aspects of technology.

6) SAFETY AND HEALTH - Machine and hand tool safety. Eye safety. Traffic patterns (industrial). Materials handling.

7) PSYCHOMOTOR SKILLS - Eye-hand coordination. Manual dexterity. Experiment with practice on several tasks. Get students to consider the transfer aspects of repeating tasks.

8) CAREER RELATED - Machine operator, supervisor, quality controller, production supervisor, management, engineer, finance, economics, sales, purchasing, transportation, logistics, etc.

9) CREATIVE PROBLEM SOLVING - Opportunities for creative problem solving will be provided by this TLA including: identification and definition of a problem, goal and criteria setting, generation of alternative solutions and recognition of limitations, optimization, testing, and evaluation.

10) TRANSFER OF LEARNING - The relationship between craft production and factory production. Specialization. Productivity, systems, subsystems in machines, purchasing in volume, sales, production speed, efficiency, etc.

BACKGROUND REFERENCES AND RESOURCES

Galey, Minaruth. "You, Me and Technology" Video Cassette. Agency for Instructional Television, 1111 W. 17th Street, Bloomington, Indiana 47401.

Gerbracht, Carl & Robinson, Frank E. *Understanding America's Industries*. Bloomington, Il: McKnight & McKnight Publishing Co., 1962.

Jensen, Thomas R. & Wright, R. Thomas. *Manufacturing*. South Holland, Il: The Goodheart-Wilcox Company.

Lux, Donald G. & Ray, Willis E. *The World of Manufacturing*. Bloomington, Il: McKnight & McKnight Publishing Co., 1971.

EVALUATION

The teacher should develop a two component evaluation system to determine if the student understands: (1) performance objectives and (2) skills, attitudes, knowledge & safety related to the specific lab activity.

(1) EVALUATION OF PERFORMANCE OBJECTIVES (Examples)

1. Given a set of blank systems diagrams, the students will be able to complete them from memory of their classroom production experience. 1a

2. Given a new hypothetical situation, the students will be able to complete all phases of a block systems diagram including how the hypothetical system relates to the classroom experience. 1b

3. Given a hypothetical situation for each of the three aspects of technology, the students will be able to describe the monitoring and feedback portions which were used in the specific cases. 2a

4. Given a list of materials tested in the school laboratory, the students will be able to describe how several of the materials were tested and give the general results of the tests. 2b

5. Given some new materials to be tested, the students will make suggestions for testing the new materials. 2c

6. Each student is given similar/different materials to test. The student analyzes the material and tells how s/he would test the substance and why s/he would test it in a particular manner for personal safety. 2c and 3d

7. Given a need, the student is asked to design an open-loop system to satisfy the need. S/he then will close the loop by describing the activities necessary to do so. 3b, c

8. The student is given an example of a technological device or process for the three aspects of technology. S/he is asked to identify subsystems involved in the device. 4a

Transfer of Learning

1. Given an example of a fruit or vegetable, the student will identify several systems and subsystems that must be utilized in the production of that item and show the relationship to some aspect of what the students accomplished in the laboratory situation. PO1

2. Given a list of materials that were tested in class, the student is asked to choose one of the materials for a hypothetical situation. Additionally, the student must remember and be able to write down the determinants for finding the appropriate properties in the chosen material. PO2

3. Given an open-loop system that produced a manufactured item, the student must close the loop system and show how this change in the system would prepare a better product for society and save energy in the process. PO3

4. Given a particular situation, the student will identify subsystems and systems that are being used in the

process. The student will show how the subsystems can be combined with other subsystems to make entirely new systems. The student will then show how the resultant technology can affect the human *condition. PO4*

(2) EVALUATION OF SKILLS, ATTITUDES, KNOWLEDGE & SAFETY (Examples)

1. Given a picture/sketch of an unsafe procedure in the use of a testing machine/device, the student will recognize the error and indicate how to correct the situation by verbalizing/choosing/writing the proper response to the situation.

2. Given several pictures/sketches of testing devices, the student will be able to detail the placement of stock for safe testing and give the proper general characteristics for the tests involved.

3. Students celebrate junk day. Each brings in a piece of technology that has been discarded by someone other than the student. Each student takes the piece of technology (machine, appliance, device) apart and studies and analyzes it for systems and subsystems. Each student reports the findings through systems diagrams and makes suggestions for repairing the piece or redesigning the piece for better service to society. To salvage the piece is one of the high priorities. (Skills, attitudes, knowledge, and safety can be evaluated in this manner by an observing teacher.)

Transfer of Learning

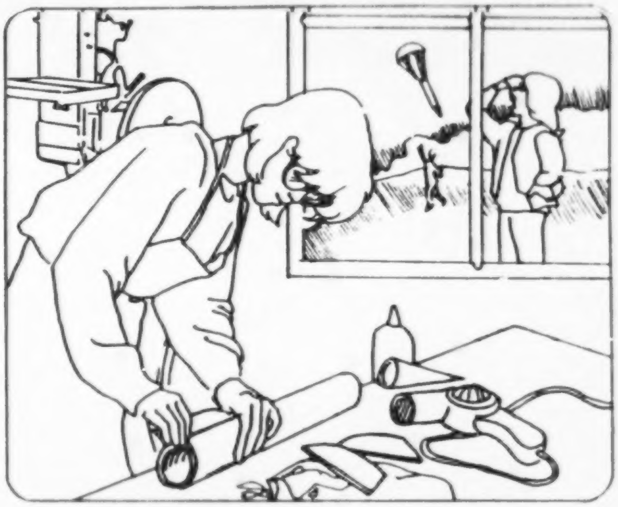
1. Given a blank of wood, the student is asked to perform a given operation. The teacher observes the actions of students during operation for clues to knowledge, safety, skills, and attitudes during the performance.

2. Teacher has prerecorded the sounds produced by the various machines on a good quality tape recorder. The student is asked to identify the machine in operation.

3. Given a tape recording of a machine being abused, the student is asked to describe the machine being used, what is happening to the machine, and why it is happening.

INTRODUCTION TO TECHNOLOGY TECHNOLOGY LEARNING ACTIVITY

SYSTEMS AND SUBSYSTEMS IN MODEL ROCKETRY



MODULE NUMBER: T-4
NUMBER OF DAYS: 20-26

MAJOR CONCEPTS TO BE ADDRESSED

T-4A New technologies often evolve as a result of combining existing technologies (confluence of systems.)

T-4B A technological system is one through which a technological process combines resources to provide an output in response to a command input.

T-4C People design systems to satisfy their needs and wants.

T-4D The basic systems model can be used as a tool to analyze systems in all of the aspects of technology.

T-4E When two or more systems are combined to form a new system, the original systems become subsystems of the new system.

T-4F People combine subsystems in order to produce more powerful systems.

T-4G Open-loop systems are unable to adjust for changing conditions.

T-4H The addition of feedback to open-loop systems provides an increased measure of control to the resulting closed-loop system.

OVERVIEW OF TLA

In this activity students will study the nature, function, and control of technological systems through the construction of model rockets. The systems and subsystems contained within the model will be investigated as well as their relationship to flight performance. The culmination of this activity will be pre-flight testing, launching of the model, and monitoring systems in operation.

EQUIPMENT AND SUPPLIES

- Estes Alpha No. L225
- Rocket engines 1/2AG-2, A8-3
- White glue
- Abrasive paper
- Sanding sealer
- Spray paint - assorted
- Hobby knife
- Masking tape
- Protractors or altitrak
- Launch pad
- Optional: Heat gun or hairdryer

PROCEDURE FOR THIS ACTIVITY

Days	POs*	Teacher Activity	POs*	Student Activity
1-2	1a 1c 1b 2a 4c PO1	Introduce systems block diagrams as a graphic means of modeling systems. Identify block parts and their function within the system diagram. Demonstrate simple block diagrams of systems within each of the aspects of technology.	1c 1a,b 2a 4c PO1	Record information and exchange ideas with class and teacher. Label parts of system diagram. Diagram systems in three areas of technology.
1-2		Introduce model rockets as a combination of systems and subsystems designed to overcome natural forces and achieve flight at a high altitude.		Interact with teacher on the topic.
	4a	Introduce the subsystems of the model rocket as propulsion, guidance, recovery, structural, and ignition.	4a	Interact with teacher on the topic.
		Test launch rocket for students to monitor systems in action.		Observe and monitor systems in action.
1-2		Demonstrate and describe the forces that act on rocket's flight (i.e., weight, lift, drag, and thrust).		Exchange ideas with teacher and class. Place force concepts in notebook.
2-3	2c	Demonstrate construction of propulsion system and guidance system within kit or design of fabrication if kits are not used. 1. cutting fins 2. forming leading and trailing edges by sanding, filing, etc. 3. glue rocket pieces	2c PO2	Observe lessons on safe use of equipment. Construction begins.
1		Introduce Newton's laws and how they relate to rocket flight. Instruct students in the use of altitude prediction math. Guide students in engine selection.	PO2	Record information. Construction continues. Perform altitude prediction math. Determine engine to use to propel rocket to an altitude of 500 feet.
2-3		Demonstrate fabrication of nose cone using various machining techniques. If using kit, demonstrate making structure aerodynamically correct. Demonstrate construction or fabrication of recovery system.	PO2	Construction and fabrication continues.
2-3	2b	Demonstrate string testing of finished rocket. Demonstrate correction of systems if, after observation, rocket proves to be unstable.	3d PO2 2b 2b,2c	Complete construction and fabrication. String-test rocket and observe effects. Make corrections in systems as needed.

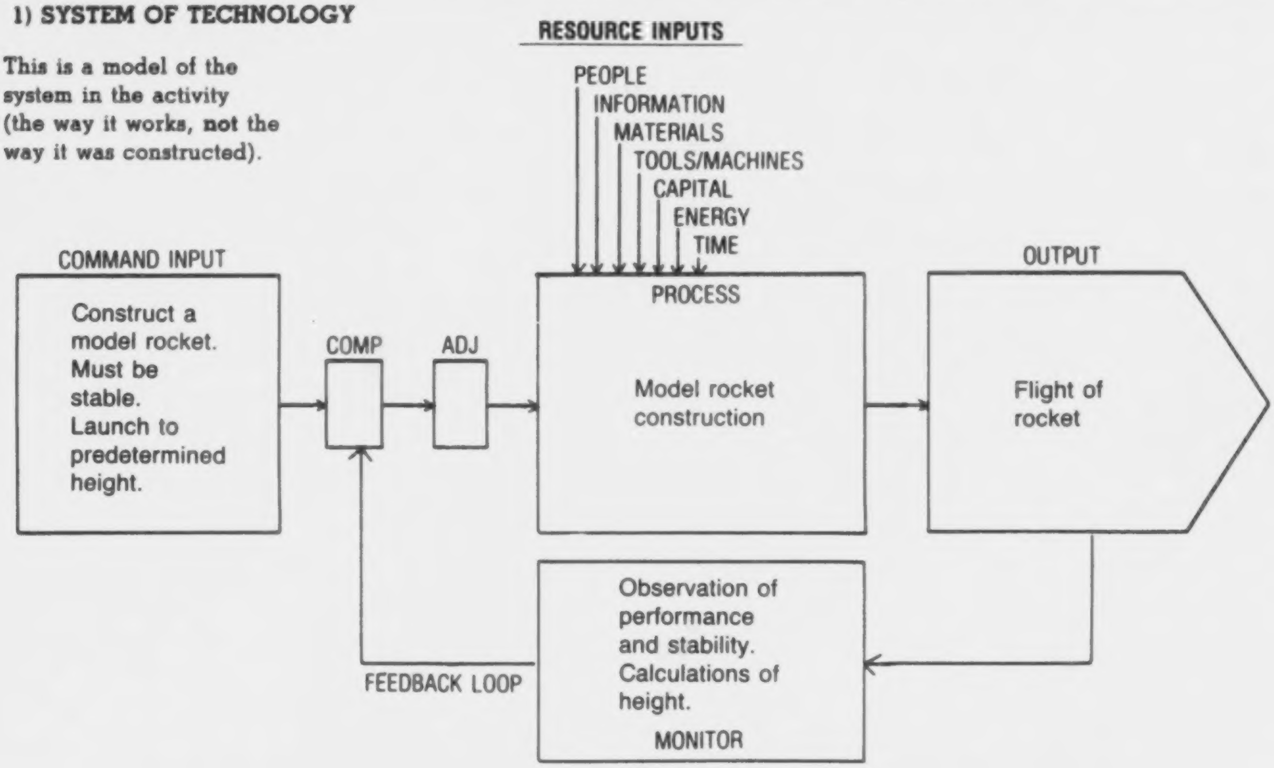
Days	POs*	Teacher Activity	POs*	Student Activity
2-3	PO2	Help students diagram systems in action.	1b	Draw systems diagram of systems in action.
		Demonstrate ignition system use, and the packing and use of the recovery system. Introduce model rocket safety code. Give test on safety code.		Practice installation. Pass written test.
2		Review launch procedures and safety code.	3b	Launch and determine rocket altitude. Compare desired results (500 feet) to the actual results.
2	3a 3c PO3	Introduce open- and closed-loop systems as they relate to the control of the model rocket in flight. Discuss options for change in system if rocket did not go 500 feet.	3a 3c 3b PO3	Diagram open-loop guidance system and closed-loop. Modify rocket for 500 feet altitude, i.e., change engine weight, nose cone, fins.
2		Monitor safe procedures. Review how systems and subsystems in rockets combine to achieve a desired outcome.		Launch rockets. Record height. Exchange of ideas and experiences.
	4a	Define systems and subsystems.	4a	Record information
1	4b	Discuss systems and subsystems found in nature (circulation: heart, lungs, veins, etc.).	4b	List other systems and subsystems in nature.
	4b	Discuss systems and subsystems found in other areas of technology. Introduce the transportation system and have the students break it down into its systems and subsystems (land, sea, air).		Break down the transportation system into its systems and subsystems.
	4c	Aid students in diagraming these systems and subsystems.	4c	Diagram these systems.
1	PO4	Assign students to list and diagram other modern complex systems into their subsystems.	PO4	List other complex systems and their subsystems. Explain how they combine to form new systems and improve human capabilities.
		Review for test.		Take test on Module 4.
22 Total Days				

*See Syllabus for phrasing of performance objectives and supporting competencies.

CONSTANTS FOR INFUSION INTO THE TLA

1) SYSTEM OF TECHNOLOGY

This is a model of the system in the activity (the way it works, not the way it was constructed).


RESOURCE INPUTS
PEOPLE
INFORMATION
MATERIALS
TOOLS/MACHINES
CAPITAL
ENERGY
TIME
COMMAND INPUT
Construct a model rocket. Must be stable. Launch to predetermined height.
COMP
ADJ
PROCESS
Model rocket construction
OUTPUT
Flight of rocket
Observation of performance and stability. Calculations of height.
MONITOR
FEEDBACK LOOP

IDENTIFY THE ROLE OF THE FOLLOWING RESOURCES IN THE SYSTEM ABOVE:
PEOPLE, INFORMATION, MATERIALS, TOOLS & MACHINES, CAPITAL, ENERGY, TIME

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2) MATH - The use of triangulation to determine height and altitude.

3) SCIENCE - Newton's Laws of Motion. Potential energy and kinetic energy.

4) HUMAN & SOCIAL IMPACTS - Fitting the technology of space exploration and settlement to the environment of outer space. Who owns outer space? Changing lifestyles and the need for new types of living arrangements.

5) COMMUNICATION SKILLS - The development of a technological vocabulary. The ability to follow written and oral directions.

6) SAFETY AND HEALTH - Proper and safe use of tools and materials.

7) PSYCHOMOTOR SKILLS - The development of these skills through repeated manipulation of tools and materials.

8) CAREER RELATED - Make students aware of various job clusters and opportunities in related areas.

9) CREATIVE PROBLEM SOLVING - Opportunities for creative problem solving will be provided by this TLA including: identification and definition of a problem, goal and criteria setting, generation of alternative solutions and recognition of limitations, optimization, testing, and evaluation.

10) TRANSFER OF LEARNING - Apply systems approach to understand more complicated systems.

BACKGROUND REFERENCES AND RESOURCES

The following resources are available from:

Estes Publications, Estes Industries 227, Penrose, Colorado 81240

Industrial Arts Teachers Manual for Model Rocketry

Alpha Book of Model Rocketry

Laws of Motion and Model Rocketry

Countdown: Mathematics and Model Rocketry

EVALUATION

The teacher should develop a two component evaluation system to determine if the student understands: (1) performance objectives and (2) skills, attitudes, knowledge & safety related to the specific lab activity.

(1) EVALUATION OF PERFORMANCE OBJECTIVES (Examples)

1. Draw and label a systems block diagram showing the following components: input, process, output, monitor, comparison and resources. PO1 a,b,c

2. Draw a systems block diagram showing the function of a natural system found in the human body. PO1

3. List the systems and subsystems found in a typical auto, home computer, and home heating system. How do they improve human capabilities? PO4 a,b,c

4. Draw a systems block diagram showing how to change an open-loop door bell system into a closed-loop system. PO3 a,c

(2) EVALUATION OF SKILLS, ATTITUDES, KNOWLEDGE & SAFETY (Examples)

1. The inertia possessed by non-moving bodies may be called ________________ inertia.

2. The resistance that results when a body is moved through the air is called ____________________________.

3. The momentum of a body moving through the air is measured by multiplying ______________ times velocity.

4. A force which is not matched by an opposing force is called an __________________ force.

5. If the same thrust is applied to a small mass as to a large mass, the (large or small) __________________ mass will receive more acceleration.

6. Use only __________________ operated ignition systems to launch model rockets.

7. The only acceptable type of recovery wadding is __________________ wadding.

8. Never stand closer than _________ feet from a model rocket which is about to be launched.

9. You should __________________ attempt to recover model rockets from power lines or other dangerous places.

10. Model rockets, with engines in place, cannot weigh over _________ grams or _________ ounces.

11. Only pre-loaded __________________ model engines are to be used, and then only in the manner recommended by the manufacturer.

12. Every model rocket launched must have a _________ to return it gently to the ground so that it may be flown again.

13. Electrical ignition systems used to launch model rockets must contain a switch which will __________________ when released.

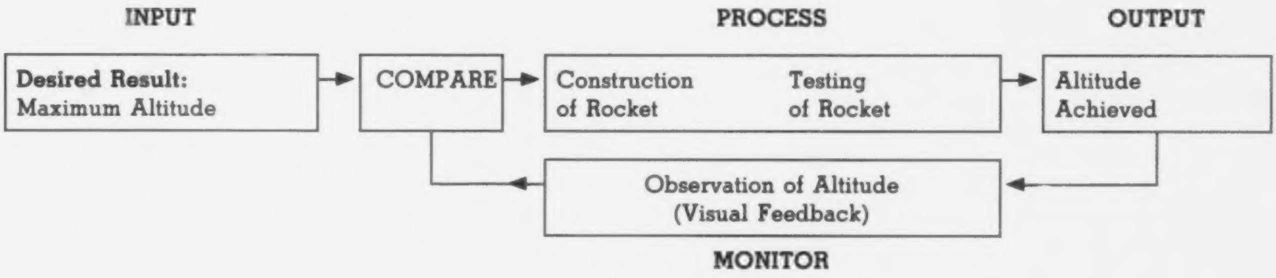
14. Model rockets never carry __________________ payloads.

15. Factory-made model rocket engines are ___________ to be reloaded.

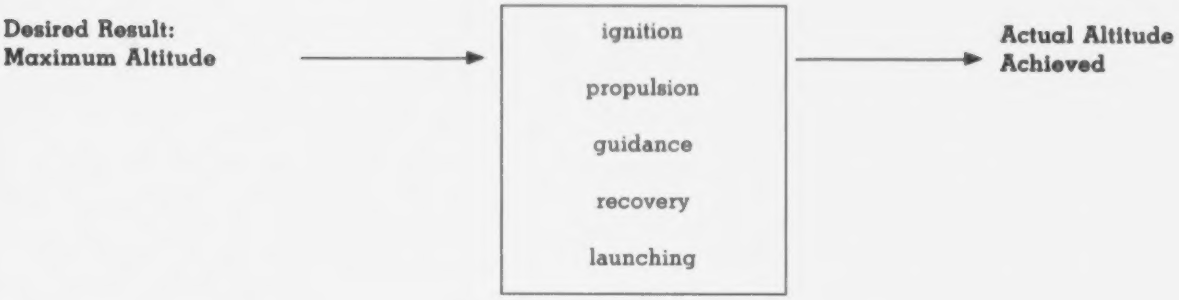
16. The launching device will always be pointed with __________________ degrees of vertical.

17. The jet deflector device prevents the ______________ from hitting the ground directly.

APPENDIX: SYSTEMS MODEL OF ROCKET CONSTRUCTION

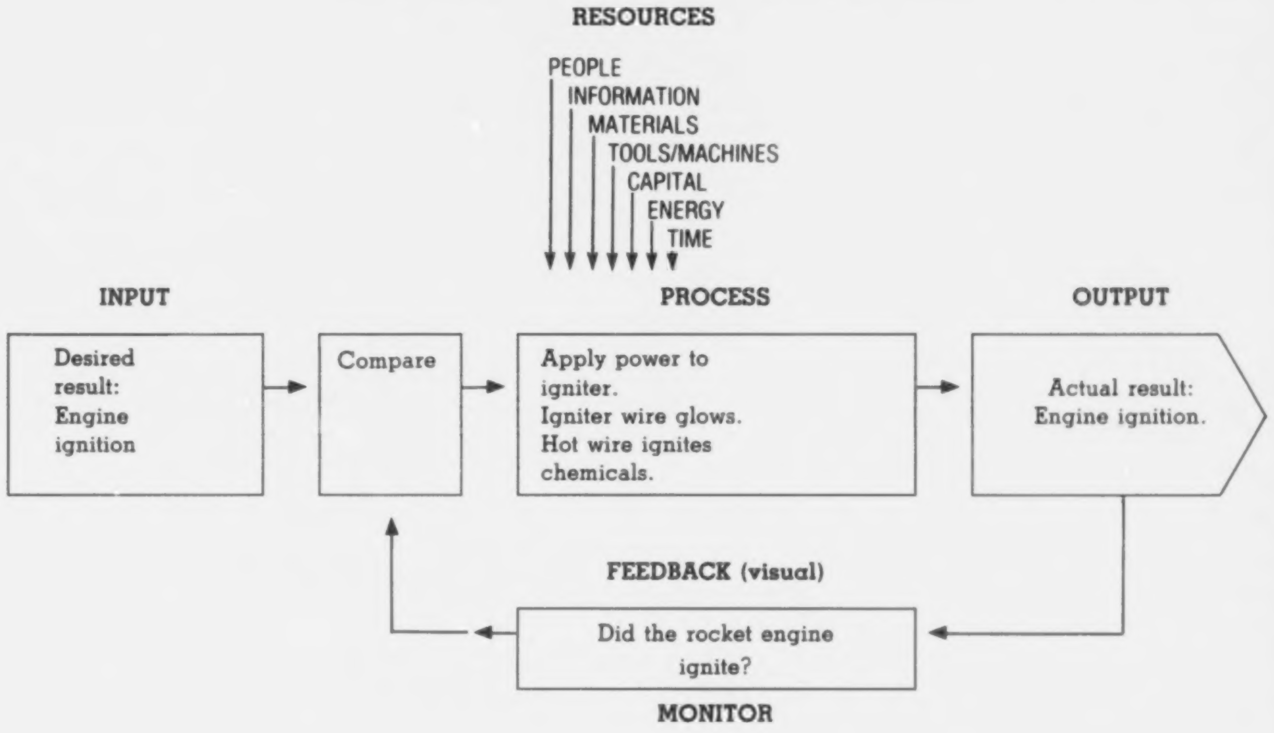

INPUT
PROCESS
OUTPUT
Desired Result:
Maximum Altitude
COMPARE
Construction of Rocket
Testing of Rocket
Altitude Achieved
Observation of Altitude
(Visual Feedback)
MONITOR

APPENDIX: MODEL ROCKETRY SUBSYSTEMS

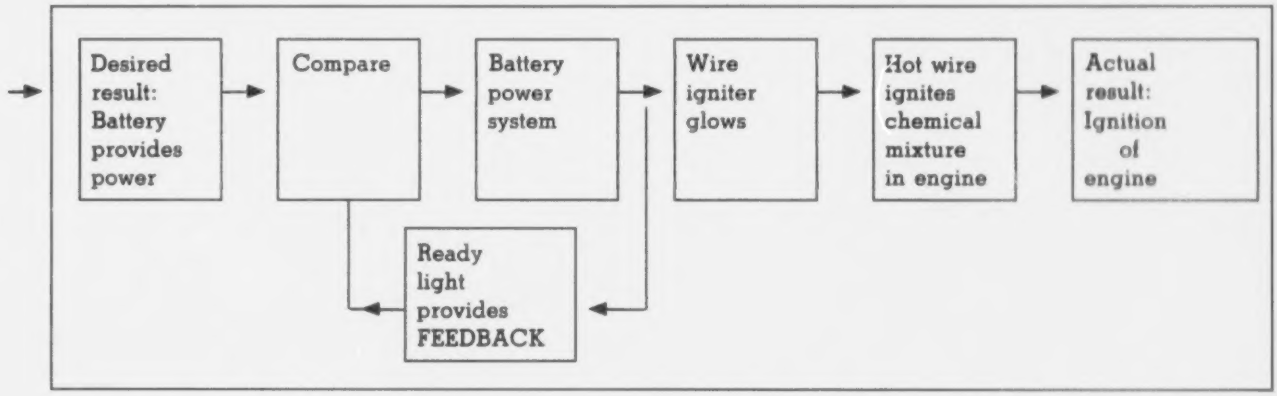

Desired Result:
Maximum Altitude
ignition
propulsion
guidance
recovery
launching
Actual Altitude
Achieved

APPENDIX: SYSTEM MODEL OF A MODEL ROCKET SUBSYSTEM

MODEL ROCKET IGNITION SYSTEM DIAGRAM


RESOURCES
PEOPLE
INFORMATION
MATERIALS
TOOLS/MACHINES
CAPITAL
ENERGY
TIME
INPUT
PROCESS
OUTPUT
Desired result: Engine ignition
Compare
Apply power to igniter. Igniter wire glows. Hot wire ignites chemicals.
Actual result: Engine ignition.
FEEDBACK (visual)
Did the rocket engine ignite?
MONITOR

SYSTEM MODEL OF PROCESS BOX (THE PROCESS OF IGNITION - A CLOSE UP VIEW)


Desired result: Battery provides power
Compare
Battery power system
Wire igniter glows
Hot wire ignites chemical mixture in engine
Actual result: Ignition of engine
Ready light provides FEEDBACK

THE PROCESS OF IGNITION - A CLOSE UP VIEW

APPENDIX: MATH AND SCIENCE CONCEPTS AND OTHER RELATED MATERIAL

Science

1. Rockets operate because of the application of Newton's three laws of motion.

2. Newton's 1st law states that an object at rest will stay at rest or an object in motion will stay in motion in a straight line unless either object is acted upon by an unbalanced outside force. This is known as inertia.

3. Newton's 2nd law states that the change in velocity of an object in motion per unit time (acceleration) is directly related to the unbalanced force acting on the object.

4. Newton's 3rd law states that for every action of an object, there is an equal and opposite reaction on the object.

5. In order to overcome the inertia of the rocket and provide it an acceleration, a large unbalanced force is applied to the rocket by the engines. This force is applied in an opposite direction to the desired direction of motion.

6. As the rocket gains altitude, it also gains gravitational potential energy which tends to pull it towards the center of the earth.

7. To overcome the gravitational potential energy and leave earth, the force from the rocket's engines must accelerate it to a speed of 11.2 Km/sec. This is a constant for all rockets and is called the escape velocity.

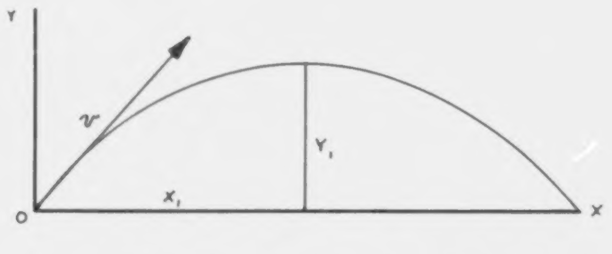
Math

1. "Calculations of altitude" and "measurement of angles and base line" are already indicated in the TLA.

2. To help the 7th grader calculate altitude, consult "The Handbook of Model Rocketry," by G. Harry Stine, 5th ed.

3. Use a computer with a Basic program that will allow students to input data and get altitude.

4. The motion of projectiles is a parabolic curve.



5. The velocity has a vertical and horizontal direction. Some background in trigonometry of the right triangle seems necessary to understand the formulas to find out how high it will go. Trigonometry of the right triangle is in the 8th grade math curriculum.

INTRODUCTION TO TECHNOLOGY TECHNOLOGY LEARNING ACTIVITY

HYDROPONIC GREENHOUSE

MODULE NUMBER: T-5
NUMBER OF DAYS: 19-25

MAJOR CONCEPTS TO BE ADDRESSED

T-5A The output of a technological system can be desired, undesired, expected, or unexpected.

T-5B Technological advancements produce many positive outcomes and solve many problems, but sometimes there are negative outcomes which create new problems like pollution, crowded highways, and an imbalance in our ecosystem.

T-5C Technology should be adapted to the human user (ergonomics).

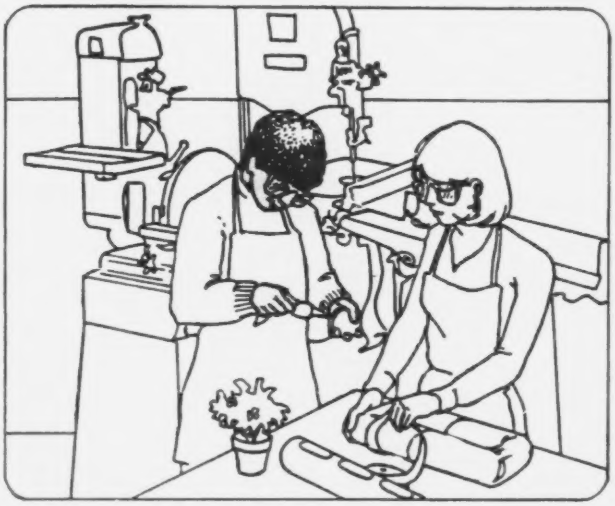
T-5D Technology should be adapted to the environment (appropriate technology); the environment can be natural, human-made, or both.

T-5E Humans develop and control technology.

OVERVIEW OF TLA

Technology can provide us with many improvements, but can also create undesired consequences. If we are to use technology properly, we must be able to predict undesirable outputs and better match the technology to the user and environment.

Through the construction of a hydroponic greenhouse, students will demonstrate how better matches of technology to user and environment can be achieved. The activity will include growing food products using alternative technologies and predicting desired and expected outcomes.



EQUIPMENT AND SUPPLIES

Hand tools and machines needed:
Tinplate
1/2" wood stick
Wire
Clear plastic
Plants
Water
Nutrients
Aggregate

PROCEDURE FOR THIS ACTIVITY

Days	POs*	Teacher Activity	POs*	Student Activity
1-2		Place sample block diagrams of systems on the board leaving the output box empty. Select systems that represent major positive and negative impacts on society (production, robotics, energy, etc.).		Record the information in notebook.

Days	POs*	Teacher Activity	POs*	Student Activity
	1b	Discuss and define desired, undesired, expected, and unexpected outputs of technology.	1b	Participate in discussion.
	1a 1b 1c	Use above examples and analyze possible outputs.	1a 1b 1c	Fill in output boxes and analyze outputs in terms of possible expected, unexpected, desired, and undesired outputs. Record information in notebook.
1		Introduce hydroponics as a system of cultivation in liquid nutrients rather than traditional soil.	1c	Block diagram a hydroponic and traditional growing system.
		Help students block diagram the system. Help students list all possible outcomes from the system (desired, undesired, expected, and unexpected) and compare to traditional growing system outcomes.	1a 1b 1c	List possible outputs of both systems as desired, undesired, expected, and unexpected. Compare outputs.
10-15	1d 2c 3c	Provide instruction and demonstration on fabrication of a model hydroponic greenhouse. Instruction should include the following: • safe use of tools and machines • material forming methods based on addition, separation, contour, and internal changes • material selection	1d 2c 3c	Observe demonstrations. Construction begins.
1		Instruction on how to grow plants in model greenhouse.		Complete construction. Grow plants in model greenhouse (sprouts grow in three days).
	PO1	Show students how to fill out log on plant activity (outputs).	PO1	Observe and record output in notebook.
1	2a 2b	Define the term ergonomics. Give examples of poor ergonomics (unsafe auto, pollution, etc.). Discussion with students about lack of fit between traditional farming techniques and the user of farm products. This should include: • food products contaminated with pesticides • infiltration of pesticides and fertilizers into local drinking water.	2a 2b	Record information. Give other examples of poor fit between technology and user. Participate in discussion.
1	PO2	Discussion on hydroponics as an alternative technology to traditional farming.	PO2	Experiment with different hydroponic growing methods (misting, drain down, etc.) to demonstrate how to overcome the lack of fit between traditional methods of growing and the user.
1	3a	Discussion on undesired effects of technology on the environment and the impacts on traditional growing methods.	3a 3a	Participate in discussion. List other undesired effects of technology on traditional growing methods.

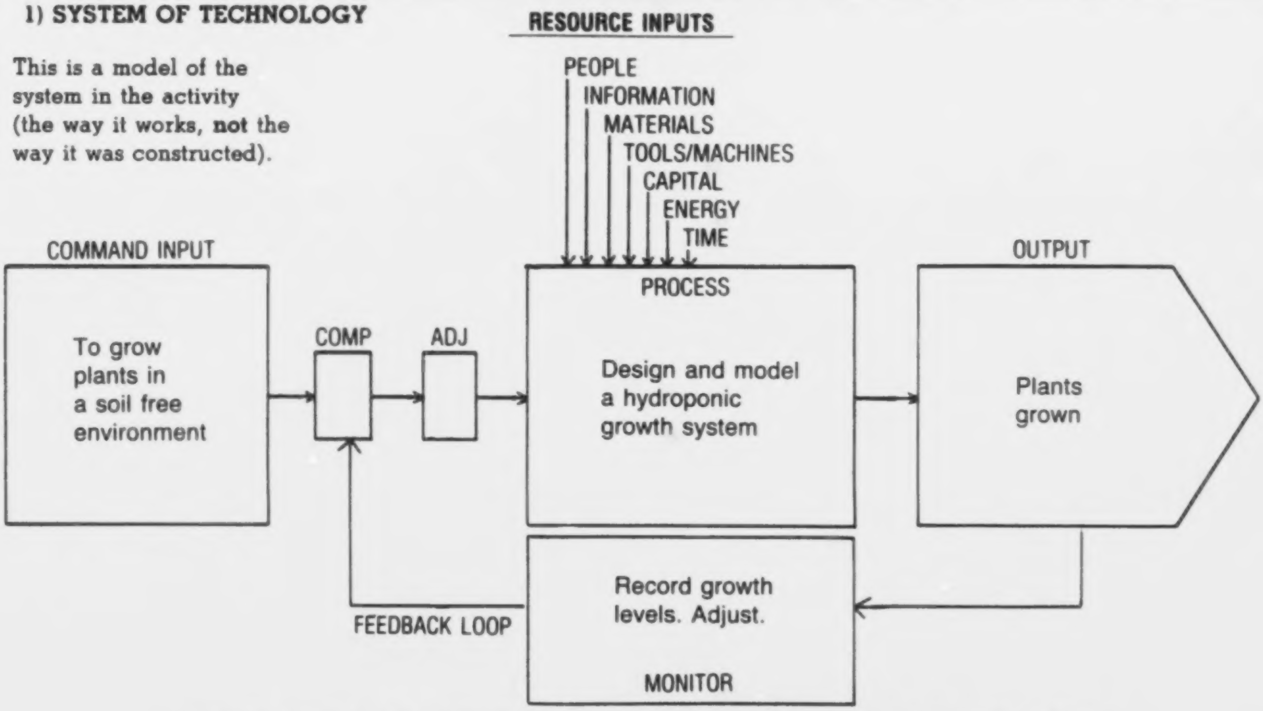
Days	POs*	Teacher Activity	POs*	Student Activity
	3a	List common undesired effects of technology on the environment that affect growing (acid rain, soil depletion due to overproduction, change in weather conditions).		
3	3b PO3	Assign the following activity to be done for homework: • research the cause of negative environmental impacts due to the lack of fit between technology and user. • relate this to impacts on traditional farming. • suggest modifications for improving the fit.	3b PO3 PO3	Research the data behind environmental problems and report them to the class. Suggest improvement that would make a better fit between technology and user. Use the hydroponic greenhouse to demonstrate how lack of match can be improved. Model the improvement in the hydroponic greenhouse.
19-25 Total Days				

*See Syllabus for phrasing of performance objectives and supporting competencies.

CONSTANTS FOR INFUSION INTO THE TLA

1) SYSTEM OF TECHNOLOGY

This is a model of the system in the activity (the way it works, **not** the way it was constructed).


RESOURCE INPUTS
PEOPLE
INFORMATION
MATERIALS
TOOLS/MACHINES
CAPITAL
ENERGY
TIME
COMMAND INPUT
To grow plants in a soil free environment
COMP
ADJ
PROCESS
Design and model a hydroponic growth system
OUTPUT
Plants grown
FEEDBACK LOOP
Record growth levels. Adjust.
MONITOR

IDENTIFY THE ROLE OF THE FOLLOWING RESOURCES IN THE SYSTEM ABOVE:
PEOPLE, INFORMATION, MATERIALS, TOOLS & MACHINES, CAPITAL, ENERGY, TIME

2) MATH - Linear and angular measurements, percentage calculations, liquid measurements.

3) SCIENCE - Concept of pH level, elements and compounds, measurement of light and moisture, plant characteristics, greenhouse effect, plant structure.

4) HUMAN & SOCIAL IMPACTS - After exploring the current state of traditional agriculture (overproduction, subsidies, soil depletion) students would consider the impacts of this technology.

5) COMMUNICATION SKILLS - Interpretation of technical drawings, gathering and recording data from various instruments.

6) SAFETY AND HEALTH - Safe use of tools and materials. The consideration of environmental pollution due to the use of pesticides and fertilizers.

7) PSYCHOMOTOR SKILLS - Use of fine and gross motor skills in the use of tools and equipment. Development of figure ground, spatial relationships, and visual discrimination.

8) CAREER RELATED - Exploration of careers and occupations in the horticulture field, construction industry, electronics, science and math professions.

9) CREATIVE PROBLEM SOLVING - Opportunities for creative problem solving will be provided by this TLA including: identification and definition of a problem, goal and criteria setting, generation of alternative solutions and recognition of limitations, optimization, testing and evaluation.

10) TRANSFER OF LEARNING - Vegetation may be used for production of methane gas which generates energy. Human production of methane gas in the digestive system.

BACKGROUND REFERENCES AND RESOURCES

Books on Hydroponics

Author	Title	Lib. Ref. No.
Dickerman, Alexandra & John	Discovering Hydroponic Gardening	631.585 D
Harris, Dudley	Hydroponics-Growing Plants Without Soil	631.585 H
Kramer, Jack	Gardens Without Soil	631.585 K
Kenyon, Stuart	Hydroponics for the Home Gardener	631.585 K
Nicholls, Richard E.	Beginning Hydroponics	631.585 N
Sholto Douglas, James	Hydroponics Bengal System	631.585 S
Sholto Douglas, James	Beginner's Guide to Hydroponics	631.585 S
Sholto Douglas, James	Advanced Guide to Hydroponics	631.585 S
Saunby, T.	Soiless Culture	631.585 S
Sullivan, George	Hydroponics-Growing Plants Without Soil	631.585 S

Classroom Equipment

Supplier	Item	Cost
Creative Learning Systems 9889-E Hibert Street San Diego, CA 92131	Hydroponic Greenhouse Plant Food	$54.99 $ 4.99

Note: Many of the books above list additional resources for obtaining supplies and information.

EVALUATION

The teacher should develop a two component evaluation system to determine if the student understands: (1) performance objectives and (2) skills, attitudes, knowledge & safety related to the specific lab activity.

(1) EVALUATION OF PERFORMANCE OBJECTIVES (Examples)

1. Select two technological systems and give examples of desired, undesired, expected, and unexpected outputs of that technology. PO1

2. Define the term ergonomics. 2a

3. Give examples of the lack of fit between technological systems and the human user that may be found at home or school. Suggest alternatives that might improve the match. PO2

4. Give examples of a lack of fit between the technological system and the environment that are found worldwide. Suggest alternative technologies that might improve the match. PO3

(2) EVALUATION OF SKILLS, ATTITUDES, KNOWLEDGE & SAFETY (Examples)

1. List three advantages of hydroponic growing over conventional farming.

2. In what parts of the world are we most likely to find a fast growing hydroponic industry?

3. What does pH measure?

4. Why must misting or drain down methods of hydroponics be used rather than allowing the root structure to sit in the nutrient solution?

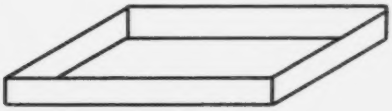
5. Explain the greenhouse effect.

6. How else can the greenhouse effect be put to practical use?

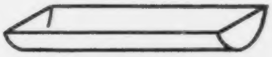
APPENDIX: MATH AND SCIENCE CONCEPTS AND OTHER RELATED MATERIAL

MATH

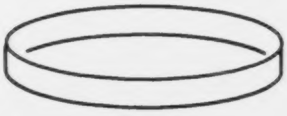
1. In construction of container, students consider various geometric solids which can be used to hold growing medium for plants.



rectangular prism



part of cylinder



cylinder

2. Calculate surface area and volume of each container.
3. Calculation of nutrients to be added (use of ratio and proportion).
4. Measurement: use of fractions in linear measurement (of greenhouse).
5. Figure rate of evaporation where liquid medium is used. Possible design of an automatic feeder (replacement of water).
6. Calculate tomato production as to yield per volume of space needed.

APPENDIX: MATH AND SCIENCE (Continued)

SCIENCE

1. All plants require nutrients to grow and live.
2. Plants get their nutrients from diverse sources, depending on their environment.
3. Seeds of plants will germinate with no nutrients present.
4. Germination usually requires moisture and light.
5. Nutrients enter plants through roots.
6. Nutrients are dissolved in water before entering the roots of plants.
7. Plants can be grown in artificial substrates that provide nutrients to the plants.
8. pH is a measure of how acidic or how basic a substance is. pH paper is a simple way to measure pH.
9. Many plants are very pH sensitive. They survive only if their substrate is maintained in a narrow pH range.
10. Plants require light to live. The light is used in photosynthesis.
11. Plants use only certain wavelengths of light.
12. If artificial light is used, the correct wavelength must be present.

APPENDIX: RELATED INFORMATION

I. Why use hydroponics?

- a. Weeds are eliminated.
- b. Labor involved in the caring for crops greatly reduced.
- c. Grow many more plants in a relatively small space.
- d. Conserve water and nutrients as they are recycled.
- e. Grow plants in environment where the soil will not support plant growth.
- f. Grow faster and larger yields.
- g. Eliminate insects.
- h. Grown plants where no soil exists.
- i. Expand the scope of gardening for apartment dwellers.

II. History

- a. Hydroponics - Greek word meaning water working.
- b. Aztecs forced to live in marshlands raised plants on floating human-made islands.
- c. 1935, Dr. Gericke experimented with hydroponics in his California lab and grew 25 tomato plants. He began the large interest in hydroponic farming.
- d. During WW II soldiers in the Pacific grew their own food using hydroponic method.
- e. Today, virtually no continent can exist without some form of hydroponic gardening either for food supply or for commercial use.

III. Needed Vocabulary

- a. Hydroponics - a method of growing plants without soil.
- b. Nonsoil medium: Examples - gravel; sand; crushed rock; crushed brick; shards of cinder blocks.
    1. Water culture method - growing in water or water and nutrients only.
    2. Sand culture method - growing in sterile sand that has nutrients pumped through it.
    3. Aggregate culture method - growing in gravel or vermiculite with nutrients pumped through it or misted.

APPENDIX: RELATED INFORMATION (Continued)

IV. Basic Concepts

a. Living things die and fall to the ground and bacteria break down the structure. This material becomes nutrients which enter the soil.
b. Plants do not need soil, only the nutrients in it.
c. Nutrients in the soil are dissolved by water and enter the plant through its root system.
d. In soil grown plants, roots grow to find water with its dissolved nutrients in it.
e. In hydroponic gardening, the plants absorb the nutrients in a liquid state without having to search for it in the soil.
f. Roots stay small so many more plants can be grown in a small area.
g. In hydroponics nutrients are re-used; in soil gardening, these fertilizers are lost.
h. Every day, 200,000 barrels of soil are used to produce soil fertilizers.
i. Not all plants may be grown hydroponically. Ex. corn, cereals.

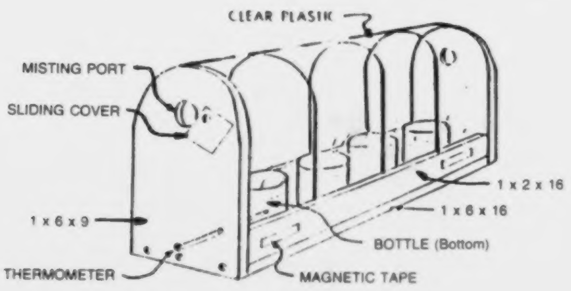
V. Hints for Small Scale Hydroponics

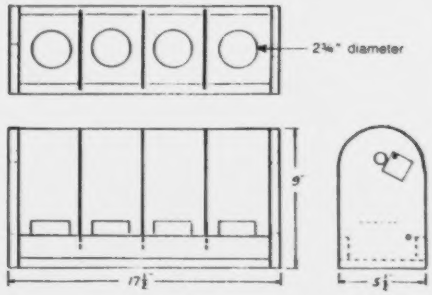
a. Any container may be used to grow plants in it so long as it can hold liquids.
b. A lid or cork is needed to support plant and allow its roots to sit in nutrients.
c. Any plant food may be used, but reduce dose by 1/2 of manufacturer's recommendations. Better to use too little than too much.
d. Check the pH level using an inexpensive pH test kit - may be purchased in a garden supply center or aquarium supply store.
e. Let water stand for 24 hours before adding the nutrients to allow chlorine to evaporate.
f. Begin seedlings in plain water for 1-2 weeks before adding nutrients.
g. Change water and nutrients every 3 weeks.
h. **Do not** add nutrients as water evaporates, **add water**.
i. Aggregate (aquarium gravel, washed) can be added to the bottom of the container to anchor plants.
j. Concept of pH level and testing:
-pH means the relative alkalinity or acidity of a solution, on a scale of 1 to 14, with a pH of 7 representing neutral. Readings above 7 are alkaline, below 7 are acidic.
-To lower the acidity, add baking soda. To raise acidity, add vinegar.
-pH may be tested with Litmus paper (dry test) or liquid pH test solution.
k. Sample plants and pH levels:

LIMA BEAN	6.0 - 7.0
PARSLEY	5.5 - 7.0
TOMATO	5.5 - 7.5

pH level between 5.5 - 7.0 is suitable for most plants.

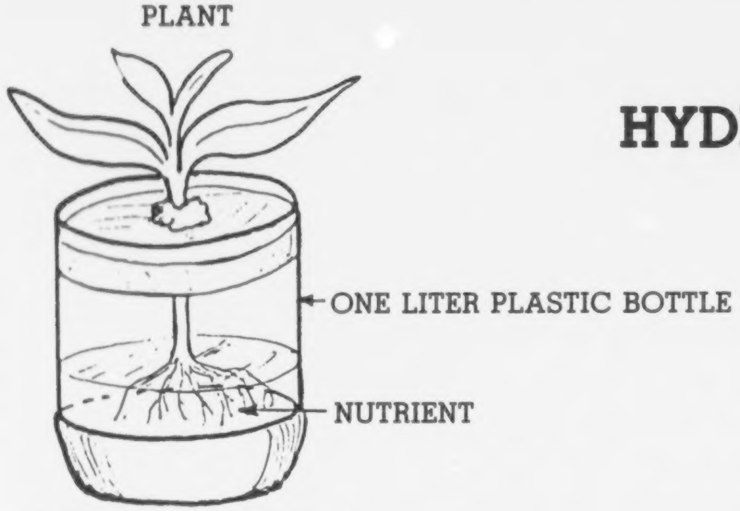
APPENDIX: HYDROPONIC GREENHOUSE



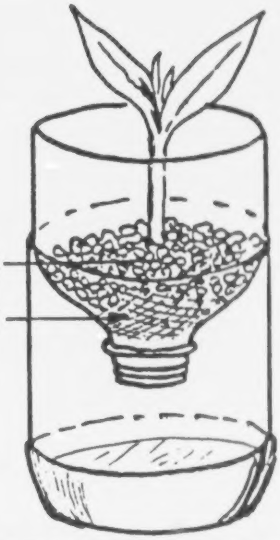


APPENDIX: CULTURE

HYDROPONICS

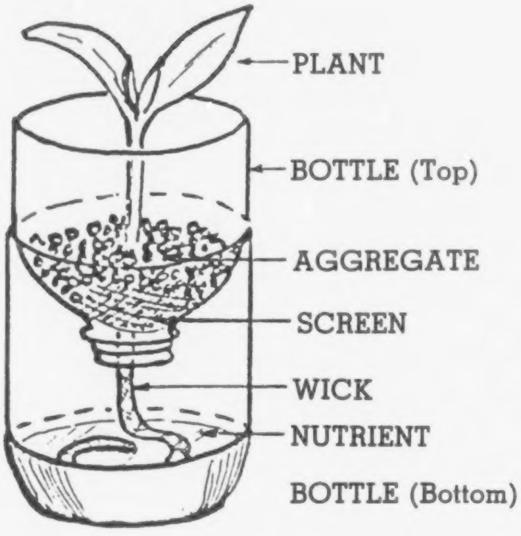

PLANT
ONE LITER PLASTIC BOTTLE
NUTRIENT

WATER CULTURE


AGGREGATE
SCREEN

AGGREGATE CULTURE

Drain Down System


PLANT
BOTTLE (Top)
AGGREGATE
SCREEN
WICK
NUTRIENT
BOTTLE (Bottom)

AGGREGATE CULTURE

Wick System

APPENDIX: LOGS

Students can use this chart to make repeated observations of conditions in the greenhouse, thereby monitoring the system.

WHAT TO MONITOR	DATE	OBSERVATION/COMMENTS
Growing Medium		
Excessive moisture in aggregate		
Aggregate too dry		
Drainage too rapid		
Drainage too slow		
Frequency of pumping periods		
Depth of nutrient reservoir		
Nutrient Solution		
Water analyses performed		
pH level		
Climate		
Sufficient light		
Too much light (i.e., heat)		
Ventilation		
Day/night temperature differential		
Drafts in room		
Humidity		
Clean air		
Cleanliness of area		

INTRODUCTION TO TECHNOLOGY TECHNOLOGY LEARNING ACTIVITY

HABITATS IN AN ALIEN ENVIRONMENT

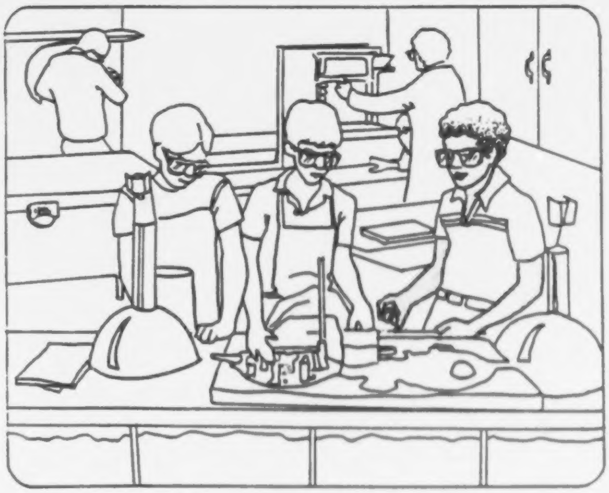
MODULE NUMBER: T-5
NUMBER OF DAYS: 18-20

MAJOR CONCEPTS TO BE ADDRESSED

T-5A The output of a technological system can be desired, undesired, expected, or unexpected.
T-5B Technological advancements produce many positive outcomes and solve many problems, but sometimes there are negative outcomes which create new problems like pollution, crowded highways, and an imbalance in our ecosystem.
T-5C Technology should be adapted to the human user (ergonomics).
T-5D Technology should be adapted to the environment (appropriate technology); the environment can be natural, human-made, or both.
T-5E Humans develop and control technology.

OVERVIEW OF TLA

Given an alien environment which is hostile to human life (e.g., the moon, the ocean, underground), students will design a structure using technological systems which would permit life support to develop. Students will then analyze the possible undesirable and unintended impacts on the alien environment as a result of the intrusion of technological systems. To vary this theme, the TLA might be adapted to focus on problems directly related to present habitable environments, some of which are being adversely affected by the intrusion of technology. Students will utilize their knowledge of ergonomics in their designs for the new environment. In their oral/written reports, students will show how humans will continue to design, develop, and control their environs before, during, and after habitation.



EQUIPMENT AND SUPPLIES

- General lab tools, machines, and materials.
- Recycled objects, containers, sheets (flat cardboard), etc.

PROCEDURE FOR THIS ACTIVITY

Days	POs*	Teacher Activity	POs*	Student Activity
1	PO1	Identify, describe, and demonstrate technological systems and their impacts both desired and undesired, expected and unexpected. Review systems theory.	1a 1b	Do related reading in *Pop. Sci., High Technology, Science 84, Life, Insight* to identify and differentiate between and among desired, undesired, expected, and unexpected outcomes from readings about systems in these periodicals.

Days	POs*	Teacher Activity	POs*	Student Activity
			1c	Apply systems diagrams of all three aspects of technolgy to these readings.
1	PO1	Demonstrate functional systems of technology to use as examples for each of the three aspects of technology. Determine that certain systems produce undesired and unexpected results (e.g., coal burning plant generating electricity whose pollutants produce acid rain). This is a novel method of introducing new materials and machines to the class. Use this technique to build and maintain interest in technological activities.	PO1	Take turns demonstrating outputs of the given systems in the three areas of technology. Demonstrate why the outcomes were unexpected and unwanted rather than expected and wanted. The skills of analysis and differentiation will be practiced.
			1a 1b 1c	Homework: Utilize systems diagrams to help in the analysis of outputs for the three aspects of technology in the home. Identify systems used every day (heat and cool control thermostats, toilet, dishwasher, microwave, etc.).
2-3	PO2	Present a scenario in which human habitation is no longer confined to the Earth's surface. Present ergonomics. Discuss design of environments and habitats. Show NASA films. Present ergonomically faulty technology. Challenge class to improve upon the faulty technology.	2a	List new alternative locations for habitats that will show understanding of ergonomics in environments alien to the human condition. Show how humans are able to solve problems and match technology to human capabilities and characteristics. Clarify goals and objectives by modifying criteria to fit new learnings in ergonomics.
			2b	Homework: select and describe a problem dealing with human condition in a human-made environment in a larger alien environment like the moon, deep ocean, and outer space.
2-3		Present information and demonstrate how modern technological systems evolve as a result of combining previous technologies. Show that combined subsystems can also produce aspects of desired, undesired, expected, and unexpected outcomes.	2b 1d	Generate alternative solutions that are adapted to human limitations. Choose one to study and model. Make model using tools, materials, machines and safety in the operation and modeling.
	2	Demonstrate how technology should be adapted to fit other natural or human-made environs and combinations of each. Show film "Connections," No. 3.	PO2	Identify lack of fit and how the model overcomes this lack of fit. Show the lack of fit in all three aspects of technology. Give specific instances where technology shapes society. Do Traditional and Emerging Technologies Worksheet (see Appendix).
1	PO3	Identify and describe systems that satisfy needs and wants of humans in a traditional structure.	3a	Identify, list, and locate outputs of technological systems in the home that do not fit the natural environment, e.g., waste disposal system — septic tank in hard pan soil. Show how these systems could be replaced or better fitted with new technological systems. Use Control Systems in the Home Environment Worksheet (see Appendix).
			3b	Research and analyze data in relation to environmental problems.

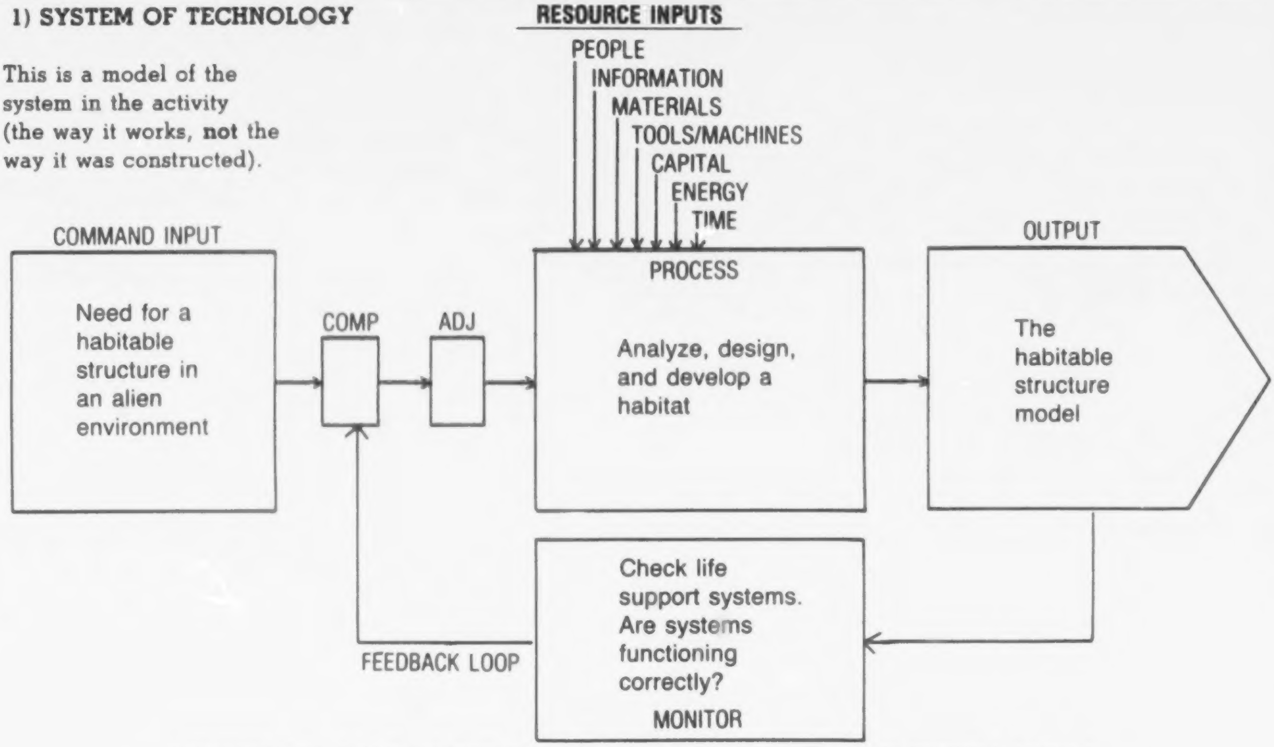
Days	POs*	Teacher Activity	POs*	Student Activity
			3c	Use tools and machines to demonstrate better fit of human-made technological systems. Determine first and second order consequences of lack of fit. After system has been redesigned, show new first and second order consequences.
2	3a 3b	Present information and demonstration of new and emerging technologies and their impact on humans and the environment. Identify outputs that are desired, undesired, expected, and unexpected. Show lack of fit between systems and natural and human-made environments.	2a 2b	Show understanding of ergonomics by bringing in a sample of a specific human-made technology that does not consider the human limitations for a physically handicapped person. (can opener for an arthritic person). Rework the object for that particular case to improve the match.
			3a	Identify undesired outputs and effects of new and emerging technology. Collect and analyze data dealing with the environment. Then use materials, tools, and machines to model improvement in the match of these new and emerging technologies with people.
3	PO3	Identify combinations of outputs of systems in natural and combination environs in which the systems show lack of fit with the environment.	PO3	Given examples of common and rare technological systems in each of the three aspects of technology, determine the lack of fit, make judgments as to the degree of lack of fit, and identify and make suggestions for the change necessary to improve the fit of the technological systems with the environments. Tools, machines, and techniques must be identified and in some cases, demonstrated to show increased degree of match of fit.
2	PO3	Review systems approach and diagrams found in T4. Stress lack of fit. Interject unforeseen problems.	PO3	Identify from given examples a lack of fit of human-made technological systems with the natural and human-made environments.
			1d 2c	Analyze and make recommendations for improvement of the fit of technological systems with natural and human-made environments.
3		Provide feedback to students about their models and reports.	3c	Work on models.
			PO2 PO3	Oral discussion of written reports on research and analysis of data in relation to environmental problems caused by lack of fit of the technological systems with the human and/or natural or human-made environments. Describe and substantiate work with discussions of actual models made during study in this module.
1		Give examination. Evaluate models.		Take examination.
18-20 Total Days				

*See Syllabus for phrasing of performance objectives and supporting competencies.

CONSTANTS FOR INFUSION INTO THE TLA

1) SYSTEM OF TECHNOLOGY

This is a model of the system in the activity (the way it works, **not** the way it was constructed).


RESOURCE INPUTS
PEOPLE
INFORMATION
MATERIALS
TOOLS/MACHINES
CAPITAL
ENERGY
TIME
COMMAND INPUT
Need for a habitable structure in an alien environment
COMP
ADJ
PROCESS
Analyze, design, and develop a habitat
OUTPUT
The habitable structure model
Check life support systems. Are systems functioning correctly?
MONITOR
FEEDBACK LOOP

IDENTIFY THE ROLE OF THE FOLLOWING RESOURCES IN THE SYSTEM ABOVE:
PEOPLE, INFORMATION, MATERIALS, TOOLS & MACHINES, CAPITAL, ENERGY, TIME

2) **MATH** - Measuring, proportion, scale, reading a meter scale, decimals, fractions and geometric shapes. Also see Appendix: Math and Science Concepts.

3) **SCIENCE** - Characteristics of life supporting environments (biological) energy sources: solar, chemical, etc. Use of units describing air flow, liquid and gaseous volumes, heat, temperature and humidity, etc.

4) **HUMAN & SOCIAL IMPACTS** - Change in lifestyle, environmental impacts - pollution, etc. Nature of employment.

5) **COMMUNICATION SKILLS** - Sketching, drawing, modeling, and presenting.

6) **SAFETY AND HEALTH** - Assure the safe use of hand and power tools. Assure the proper use of eye protection. Assure safe practices when utilizing heat producing tools. Establish procedures for clean-up.

7) **PSYCHOMOTOR SKILLS** - The student will develop or improve eye-hand coordination and manual dexterity. Specific skills will vary with the processes, techniques, tools, materials, and designs selected.

8) **CAREER RELATED** - Students participate in activities used in the fields of industrial design, engineering, modelmaking, architecture, systems planning, futuristics, and emerging occupations.

9) **CREATIVE PROBLEM SOLVING** - Opportunities for creative problem solving will be provided by this TLA including: identification and definition of a problem, goal and criteria setting, generation of alternative solutions and recognition of limitations, optimization, testing and evaluation.

10) TRANSFER OF LEARNING - The student will analyze new and emerging technologies and identify the elements of previous technologies used in each instance. For example: the student could identify the technologies on which his/her bicycle is based and the past characteristics of the vehicles preceding the bike, and recognize his/her bike's place in the development of the new bicycle technology (recumbent bikes, shrouded bikes, etc.).

BACKGROUND REFERENCES AND RESOURCES

High Technology; Popular Science; Science 84; Life; Futurist; Insight (Magazine of the Washington Post); *The Timetable of Technology; Critical Path,* R. Buckminster Fuller; *Connections,* James Burke; *Connections Video Series* #1, 3, 6, 7, 8, 10; *Search for Solutions Video Series* "Modeling"; *L 5 Society,* Tucson, Arizona; *NASA*

EVALUATION

The teacher should develop a two component evaluation system to determine if the student understands: (1) performance objectives and (2) skills, attitudes, knowledge & safety related to the specific lab activity.

(1) EVALUATION OF PERFORMANCE OBJECTIVES (Examples)

1. List the four possible outputs of a technological system and give two examples of each of the outputs. PO1 a,b

2. Define ergonomics and describe four examples from home that were not used in class discussions. PO2, a,b

3. Given a teacher-designed short scenario using the 4 outputs of a technological system, have students identify and label the four outputs in the story. PO1 a
The students should also be able to differentiate between and among the four outcomes as to their appropriateness of fit. PO2
The students will then redesign the systems for a more appropriate fit for all aspects of technology. PO2 1, b, and 1c

4. Given examples or written scenarios of technological systems which do not fit the environment, students will redesign the examples to make a better fit to the natural environment. PO3 a,b,c

(2) EVALUATION OF SKILLS, ATTITUDES, KNOWLEDGE & SAFETY (Examples)

1. Write a 2-3 page report using several current references dealing with the emerging technologies that will enable humans to colonize the moon.

2. Build a model and give an oral report on the project dealing with humans exploring, colonizing, farming, and exploiting the depths of the ocean.

3. Make a systems diagram of a space station between Earth and its moon that will show how humans can inhabit the station for years without ill effects to themselves or to the environment.

4. Ask the students to volunteer for, research and then write short episodes about future life under the sea, on another planet, or in a desert or polar ice cap. Volunteers will be given credit for its use in future classes. These written episodes can be stored on discs for future student and teacher use.

APPENDIX: MATH AND SCIENCE CONCEPTS

Math

1. Design of structure and construction of models - use of scale and proportion in drawings; measurement in metric (decimal numerals) or customary system (fractions); consideration of most efficient geometric shapes for people's needs. Consideration should also be given to size, volume, weight, strength and availability of materials.
2. Problem solving, interpreting and using data; scientific notation for large numbers.
3. Consider the concept of conservation of limited resources. Students can measure amount of water wasted if water is left running while brushing teeth; multiply to determine amount of water wasted in week or year.

Charts available in *Teaching Secondary Mathematics Through Applications* 2nd Edition by Herb Fremont, Prindle, Weber & Schmidt, 1979 (in chapter entitled, "Mathematics and Our Limited Resources").

MATH AND SCIENCE CONCEPTS (Continued)

Science

1. All living things need the same basic ingredients to survive: matter and energy.
2. On Earth, the matter comes from the makeup of Earth and its atmosphere. The energy ultimately is from the sun.
3. All living things on Earth are carbon based.
4. All living things ultimately depend on the presence of O and CO on and around the Earth.
5. All successful living things can reproduce themselves.
6. For life to survive in an alien environment, the ecology of the system must meet the above criteria.
7. Living things are related to each other and the non-living world. This is called ecology.

APPENDIX: CONTROL SYSTEMS IN THE HOME ENVIRONMENT WORKSHEET

Name ______________________________

Instructions: On the blank spaces below list the control systems in the home as they are identified and discussed in class.

TECHNOLOGIES	NOTES AND EXPLANATIONS

OUTSIDE ASSIGNMENT: Draw a sketch of a house or apartment and locate the above control systems in the proper rooms.

APPENDIX: TRADITIONAL AND EMERGING TECHNOLOGIES WORKSHEET

Name ______________________________

Instructions: Fill in the missing technologies.

Traditional (Historical) Technologies	Present (Emerging) Technologies
Example: hand saw	saber saw, water jet, laser
Example: wood burning stove	forced air furnace, pulse furnace
Kerosene lamp	
	Clothes dryer
Spring driven clock	
	Laser
Horse and carriage	
	Chainsaw
Newspaper	
	Calculator
Hand plane	
	Robot
Eyeglasses	
	Artificial limb
Telegraph	
	Space shuttle
Quill pen	
	Microwave oven

APPENDIX: LUNAR HABITABLE MODEL

EXPLANATION OF TECHNOLOGICAL SYSTEMS

Hydroponic greenhouse:
- Production of green plants for human consumption
- Conversion of carbon dioxide to oxygen during photosynthesis
- Utilization of human waste materials as plant nutrients

Electrolysis of water:
- Production of oxygen for life support and combustion
- Utilization of waste materials for fish nutrition

Laser communicators:
- Instantaneous communications

Solar cell:
- Direct conversion of sunlight into electricity for life support systems

Chemical lighting:
- Chemical reactions which produce visible light

Interstellar communicator:
- Laser/radio telescope for long distance communication

Pneumatic transporter:
- Rapid transportation system for people and materials
- Uses differential pressures to move vehicle horizontally as well as vertically

INTRODUCTION TO TECHNOLOGY TECHNOLOGY LEARNING ACTIVITY

PRODUCING AND MARKETING PHARMACEUTICAL PRODUCTS

MODULE NUMBER: T-6
NUMBER OF DAYS: 25

MAJOR CONCEPTS TO BE ADDRESSED

T-6A Resources used in solving technological problems are chosen from each of the seven resource categories.

T-6B In choosing resources, a broad familiarity with available resources and their properties is necessary.

T-6C Resources are tentatively chosen in the early stages of technological problem solving based upon identified goals.

T-6D Important factors in choosing resources are availability, cost, and appropriateness.

T-6E Information, a resource that includes numbers, graphics, and words, can be accessed through the use of computers.

T-6F In choosing resources, human and natural constraints and limitations must be considered.

T-6G Optimization, the process of choosing the best combination of resources to solve a problem, often requires compromises and tradeoffs.

OVERVIEW OF TLA

The development of a product is dependent upon a broad familiarity with the seven resources of technology as described in Module T-2. In choosing appropriate resources important factors such as availability, safety, and cost must be considered.

In this TLA students will produce products used in health care and personal hygiene which satisfy many biological needs (e.g., hand soap, hand lotion, fabric fire retardant). Every attempt should be made to include discussion and even additional activities dealing with choosing appropriate resources for the other aspects of technology.

The teacher will present a problem to the class involving the production of a pharmaceutical product. Working in groups, students will formulate a product and test market it using other students in the class. They will design labels and packaging for the products they produce. An advertisement including a "company" logo will be generated in a print, audio, or audio-visual medium.

Students will gather data and redesign their product based on analysis of this information. Factors such as smell, color, feel, and effectiveness will determine new choices in resources. Tradeoffs and compromises will have to be made. Computers will be used for both gathering and recording data.

WHERE DOES IT GO?

EQUIPMENT AND SUPPLIES

- Ounce and gram scales
- Measuring and storage containers
- Chemicals (see Appendix)
- Propane torch (for flame test)
- Computer hardware and software
- Safety equipment
- Graphic arts supplies
- Mechanical drawing equipment
- Videotape equipment

PROCEDURE FOR THIS ACTIVITY

Days	POs*	Teacher Activity	POs*	Student Activity
2		Review formalized problem solving and systems. Include resources and impacts. Show videotaped commercials for hand soap, hand lotions, deodorant, or other products. Focus students' attention on package design. Assign students to bring in samples of products filmed.	1a 3c 1b 2b 2c	Fill in flowcharts for future reference. Take notes on manufacturers' claims. Bring in sample products. Compare ingredients labels in similar products. Inspect packaging for design. Break into groups and try, test, and compare products filmed. Record results.
2	3f	Introduce pharmaceutical design problem. Explain Product Design and Specification Sheet (see Appendix). With student input, compile a list of possible products to be produced.	1a 1b 2a 3a,b,e	Research products that could be produced. Fill in Product Design and Specification Sheet. List purpose of each ingredient, process feasibility, and availability of resources.
2		Provide ingredients to mix. Choose several to demonstrate. Review the function of each ingredient within the compound. Demonstrate procedures and safe use of equipment.	2b 2c 3f	Compound basic ingredients for the product selected. Compile and analyze data on product. (Data might include smell, feel, effectiveness.)
2		Introduce the computer as a means of collecting and storing data.	4a-c PO4	Identify from a list of software which program to use for storing data. Select program and enter data on the product tested.
2	PO1	Lead a discussion on selection of alternative resources and proportions based on identified goals.	1d PO1 3f	Identify resources and alternatives. Choose alternatives. Batch ingredients based on design specifications. Have each member of the team vary the formula or amount of ingredients to obtain a product with a different character.
1	3f	Discuss safe storage, handling, and processing while working in the lab.	PO2 3d	Keep data regarding ingredient and quantity. Teams will evaluate and investigate the properties of their product samples based on goals and Design Specification Sheet. Record changes and results. Each team will select the sample product it wants "consumer tested" by other groups.
2	PO2	Give background information on consumer product testing and market research as well as material testing.	PO2	Trade products with other teams. Develop procedures for testing and data collection of the product developed by another team. Evaluate the data received from other team. Use computers for data storage.
2	PO3	Lead a discussion on optimization and instruct the students to choose the best combination of materials for their product based on the data collected from consumer testing.	3a 3b	Identify which ingredient(s) has to be changed to meet a need demonstrated by testing data (what changes in fragrance, cleaning ability, softness.).
			3c	Determine availability of material. Determine if changes can be made without introducing new problems.

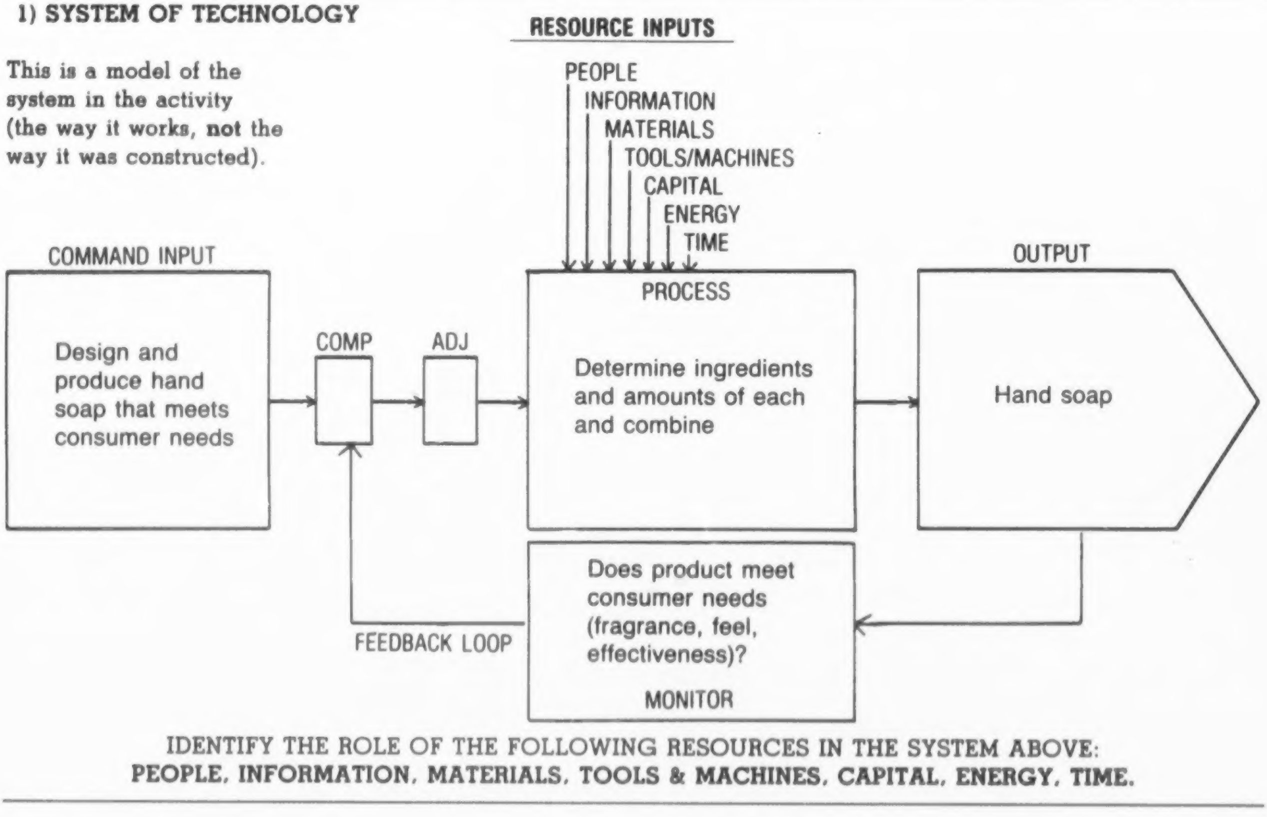
Days	POs*	Teacher Activity	POs*	Student Activity
2	3e	Explain that the perfect material system for a product may be impossible to achieve and some compromise and trade-offs may have to be made.	3e PO3	Prepare a new batch of the product using resource substitution based on testing information. Test the results after substitution and record changes in product.
1		Facilitate work.		Return "new" consumer tested product to original team for testing.
7		Introduce marketing phase, including design of label, package, and advertisement (print, audio, or audio-visual).		Design a company logo and develop several label designs. Choose one and produce an attractive package for the product. Generate an advertisement.
25 Total Days				

*See Syllabus for phrasing of performance objectives and supporting competencies.

CONSTANTS FOR INFUSION INTO THE TLA

1) SYSTEM OF TECHNOLOGY

This is a model of the system in the activity (the way it works, not the way it was constructed).


RESOURCE INPUTS
PEOPLE
INFORMATION
MATERIALS
TOOLS/MACHINES
CAPITAL
ENERGY
TIME
COMMAND INPUT
Design and produce hand soap that meets consumer needs
COMP
ADJ
PROCESS
Determine ingredients and amounts of each and combine
OUTPUT
Hand soap
FEEDBACK LOOP
Does product meet consumer needs (fragrance, feel, effectiveness)?
MONITOR

IDENTIFY THE ROLE OF THE FOLLOWING RESOURCES IN THE SYSTEM ABOVE:
PEOPLE, INFORMATION, MATERIALS, TOOLS & MACHINES, CAPITAL, ENERGY, TIME.

2) **MATH** - The use of metric units when combining wet and dry chemicals. Using both English and metric units of mass and volume in the same formula to produce a given product. Use ratios and proportions to reduce or increase amount of material produced.

3) **SCIENCE** - The differences between compounds and mixtures. Formation of saturated solutions. The properties of specific chemicals - acids, bases. Litmus test. Effects of chemicals on boiling and freezing temperatures.

4) **HUMAN & SOCIAL IMPACTS** - The cost of products based on the cost of material. The influence of advertising on the consumer. Consumer influence on product design.

5) **COMMUNICATION SKILLS** - Using the computer to gather, store, and analyze information. Interviewing techniques. Designing data sheets to record information.

6) **SAFETY AND HEALTH** - Safe use of chemicals. Proper use of eye protection when mixing chemicals. Reading labels on chemical jars. Allergies to particular chemicals.

7) **PSYCHOMOTOR SKILLS** - Students will develop or improve eye-hand coordination through manipulation of tools and equipment.

8) **CAREER RELATED** - Careers in the pharmaceutical, cosmetics, and chemical industries. Careers in marketing.

9) **CREATIVE PROBLEM SOLVING** - Opportunities for creative problem solving will be provided by this TLA including: identification and definition of a problem, goal and criteria setting, generation of alternative solutions and recognition of limitations, optimization, testing and evaluation.

10) **TRANSFER OF LEARNING** - Students will realize that in any endeavor we must be able to substitute ideas and resources if we are to reach a desired goal. Effects of chemicals on our environment. Reading labels.

BACKGROUND REFERENCES AND RESOURCES

Oxenhorn, Joseph M. Pathways in Science - *Chemistry of Mixtures*. New York: Globe Book Co., 1969.

Pinkham, Mary Ellen and Pearl Higginbotham. *Best of Helpful Hints*. Warner B. Lansky Books, 1979.

Stark, Norman H. *The Formula Manual*. Cedarburg, WI: Stark Research Corporation, 1975.

Swezey, Kenneth M. *Formulas, Methods, Tips and Data for Home and Workshop*. New York: Popular Science Publishing Co., Harper and Row, 1969.

EVALUATION

The teacher should develop a two component evaluation system to determine if the student understands: (1) performance objectives and (2) skills, attitudes, knowledge & safety related to the specific lab activity.

(1) EVALUATION OF PERFORMANCE OBJECTIVES (Examples)

1. List the seven resources of technology. Identify a minimum of three alternative resources for a given problem. PO1

2. List five properties of materials that can be tested in a non-destructive manner. 2c

3. Define the term "optimize" as used in the problem-solving method. PO3

4. What factors may determine the availability of a resource? 3b

5. Where in the systems block diagram are substitute resources entered into the system? PO3

6. What type of computer software would be helpful in data collection and analysis? PO4

7. What factors determine the suitability of a resource? 1c

(2) EVALUATION OF SKILLS, ATTITUDES, KNOWLEDGE & SAFETY (Examples)

1. What is the difference between a mixture and a compound?

2. What chemical was used for its abrasive properties in the design of hand soap?

3. List five elements found in natural form.

4. What was the basic metric unit of weight used?

5. Why are safety glasses a must when mixing chemicals?

6. What determines the fragrance selected by a manufacturer for a new perfume?

APPENDIX: PRODUCT FORMULAS

The following formulas are basic starting points for batching. Most of the chemicals can be obtained at a local pharmacy or grocery store. The percent by volume of each ingredient can be modified to obtain varied characteristics.

Quantities should be halved or quartered to obtain test size samples. Most balance scales used in batching chemicals are graduated in grams. Students should do the converting.

Teachers must ensure that safe procedures are followed in handling chemicals. They are for external use only. Eye protection must be worn at all times.

HAND SOAP (abrasive type)

- powdered pumice - 7 oz.
- powdered soap (not soap powder) - 5 oz.
- Borax - 1.25 oz.
- sodium carbonate (baking soda) - 1 oz.
- glycerin - .50 oz.
- water - 13 oz.
- abrasive substitutes - fine corn meal, fine saw dust

HAND LOTION

- soft soap - 1 oz.
- glycerin - 4 oz.
- rubbing alcohol (70% alcohol) - 15 oz.
- water - 15 oz.
- perfume as desired
- certain oils and extracts may be used as fragrance (coconut oil, spearmint oil, peppermint oil)

FABRIC FLAME RESISTANCE ADDITIVE

- Borax - 7 oz.
- boric acid - 3 oz.
- hot water - 2 quarts

Spray or dip fabric sample, dry, and test for burn through time.

DEODORANT

- alum - 2 T.
- warm water - 1 pint
- perfume as desired

LINSEED OIL SKIN LOTION

1. boiled linseed oil	1-1/2 T.	22 ml.
2. boric acid	2 t.	8 g.
3. benzoic acid	1 speck	0.3 g.
4. glycerin	3 T.	45 ml.
5. denatured isopropyl alcohol	10 T.	150 ml.
6. water	1 qt.	1 L.
7. perfume, water base	to suit	

Mixing: Mix 2 and 3 into 1, add 4 and 5. Then stir this mixture into 6, and a few drops of 7.

APPENDIX: PRODUCT FORMULAS (continued)

GLYCERIN SKIN GEL

1. gelatin	5 t.	20 g.
2. glycerin	3 T.	45 ml.
3. water	2-1/4 C.	533 ml.
4. water base perfume	to suit	

Mixing: Heat one cup of 3 to dissolve 1. To the balance of 3, add 2, then mix the two solutions and add 4 if desired.

HONEY AND ALMOND CREAM

1. stearic acid	3/4 T.	10 g.
2. ethylene glycol	1 T.	15 ml.
3. glycerin	3 T.	45 ml.
4. honey	1 t.	5 ml.
5. water	1-1/4 C.	296 ml.
6. almond oil	to suit	

Mixing: Heat 1, 2, and 3 in the top of a double boiler to 150° F. Separately heat 4 and 5 to 150° F. Combine the two and allow to cool for a few minutes. Then stir in 6, pour into containers, and cool to room temperature.

WINDOW CLEANING SPRAY I

1. ethylene glycol	2 T.	30 ml.
2. water	3 C.	711 ml.

Mixing: Stir 1 into 2.
Use: Spray on windows and wipe with squeegee or lint-free cloth.

WINDOW CLEANING SPRAY II

1. liquid detergent	1-1/2 t.	7.5 ml.
2. denatured alcohol or isopropyl alcohol	5 T.	75 ml.
3. water	4 qt.	4 L.

Mixing: Gently stir 1 into 3, then add 2. Store in bottles.
Use: Spray or sponge liberally on windows, and wipe off with a squeegee or a cloth.

WINDOW CLEANING SPRAY III

1. denatured alcohol or isopropyl alcohol	1 C.	237 ml.
2. lactic acid	5 drops	0.5 ml.
3. water	2 C.	474 ml.

Mixing: Mix 1 and 3, then stir in 2. A drop or two of regular laundry bluing may be added for blue color if desired.
Use: Spray on windows, mirrors, and so on.

APPENDIX: PRODUCT FORMULAS (continued)

GLASS SCRATCH REMOVER

1. iron oxide (jeweler's rouge)	2 T.	28 g.
2. glycerin	2 T.	30 ml.
3. water	2 T.	30 ml.

Mixing: Mix 1 and 2, then add 3 slowly until thick paste is formed.
Use: Apply with a damp cloth, which has been folded in half several times to form a pad. Rub quite hard for several minutes, or until the scratches begin to disappear. Then rinse with clean water and inspect. Rub some more if needed.

"NIVEA" TYPE CREAM

1. anhydrous lanolin	3/4 T.	10 g.
2. white petrolatum	1 C.	227 g.
3. water	2 C.	474 ml.
4. glycerin	1 t.	5 ml.
5. water base perfume	to suit	

Mixing: Heat 1 and 2 in the top of a double boiler to about 150° F., or until liquid. Separately heat 3 and 4 to about the same temperature and stir the two mixtures together. Cool until it just starts to solidify, stir in 5, and pour into jars. Cool to room temperature before covering.
Use: Use as a skin softener.

SKIN NOURISHING CREAM

1. anhydrous lanolin	2 T.	28 g.
2. stearic acid	3/4 T.	10 g.
3. triethanolamine	1/2 t.	2.5 ml.
4. water	1 C.	237 ml.
5. water base perfume	to suit	

Mixing: In the top of a double boiler heat 1, 2 and 3 until melted. Stir together, turn off heat, and add 4 and 5. Stir thoroughly, cool to room temperature, and bottle.
Use: Rub into hands and face, elbows, and other exposed areas of skin in the evening. Leave overnight. Wipe or wash off in the morning.

FIREPROOFING SYNTHETIC FABRICS

1. boric acid	1 C.	227 g.
2. water	1 gal.	4 L.

Mixing: Dissolve 1 into 2.
Use: Soak fabric in mixture, wring out, and hang up to dry. Retreat fabric after each laundering. This may be done by adding 1 to the final rinse cycle of the washing machine.

FIREPROOFING THE CHRISTMAS TREE

1. ammonium sulfate	1 C.	227 g.
2. boric acid	1/2 C.	113 g.
3. Borax	2 T.	28 g.
4. water	1 gal.	4 L.

Mixing: Mix 1, 2, and 3 into 4.
Use: Spray the tree with this solution, and use it to fill the cup of the tree stand.

APPENDIX: PRODUCT FORMULAS (continued)

FIREPROOFING FOR WOOD

1. zinc chloride	1/2 C.	113 g.
2. ferric chloride	1/4 C.	57 g.
3. boric acid	1 T.	14 g.
4. ammonium phosphate	1 T.	14 g.
5. water	2 qt.	2 L.

Mixing: Stir 1, 2, 3, and 4 into 5, mixing well.
Use: Spray or paint on areas to be protected. 3 or 4 coats are desirable.

FIREPROOFING FOR PAPER

1. ammonium sulfate	1 C.	227 g.
2. boric acid	6 T.	84 g.
3. Borax	4 T.	56 g.
4. water	3 C.	711 ml.

Mixing: Dissolve 1, 2, and 3 in 4, mixing well.
Use: Paper to be protected may be dipped in solution, or it may be brushed on areas to be protected. Use several coats, allowing each one to dry thoroughly before applying the next.

FIREPROOFING TEXTILES

1. ammonium phosphate	1/2 C.	113 g.
2. ammonium chloride	1 C.	227 g.
3. water	3 pt.	1.4 L.

Mixing: Stir 1 and 2 into 3.
Use: Soak cloth in solution for a few minutes, wring out, and hang up to dry. Cloth must be retreated ofter each exposure to water.

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APPENDIX: PRODUCT DESIGN AND SPECIFICATION SHEET

Type Of Product To Be Developed ________________

Function of Product ________________

Criteria and Specification for Product ________________

Product Formula ________________

Alternative Ingredients ________________

Changes made in formula after product testing:

APPENDIX: PRODUCT DESIGN AND SPECIFICATION SHEET
(example)

Type Of Product To Be Developed abrasive hand soap

Function of Product clean heavy dirt from hands; leave hands moist

Criteria and Specification for Product Hand soap must be in paste form, not too abrasive to the hands. Soap should have a hand moistener in it and smell fresh.

Product Formula powdered pumice, powdered soap, Borax, sodium carbonate, glycerin, water

Alternative Ingredients for abrasive — sawdust, Cornmeal

Changes made in formula after product testing:

APPENDIX: ADDITIONAL SCIENCE AND SOCIAL SCIENCE CONCEPTS

Science

Matter may exist as an element, compound, or mixture.

Compounds contain two or more elements chemically united. The properties of the compound differ from the elements composing the compound. The elements in a compound combine in a definite proportion. For example, water (H_2O) contains two atoms of hydrogen for every atom of oxygen. Compound parts are separated by chemical change. Some common compounds are acids, bases, salts, water, and alcohols.

Mixtures contain two or more elements and/or compounds that may be separated into constituent parts by physical means. Filtration, magnetism, and evaporation are ways of separating components of some mixtures. The components of mixtures occur in varying proportions. Mixtures may be found as suspensions and solutions.

Suspensions contain particles which readily settle out. Rock pieces are suspended in a rapidly flowing river.

Solutions are homogenous mixtures of solute and solvent. Salt water is an example of a solution. The particles are too small to settle out of the liquid. A solution is clear and uniform. The amount of parts of the solution may vary. The parts of the solution are the solute which is dissolved, such as salt, and the solvent, which is the dissolving medium, such as water. With the exception of gas solutes, the amount of solute that can be dissolved in a solvent increases with a rise in temperature. Solubility rate can be increased by using smaller solid solute particle size because pulverization increases the surface area that is exposed to the solvent. Generally, organic solvents like alcohol dissolve organic solutes and inorganic solvents like water dissolve inorganic solutes.

Social Science

With industrial expansion in the late 19th and early 20th centuries, competition among manufacturers increased as well. Producers sought ways of enticing consumers to purchase their products. Advertising became a big business in the United States.

By the 1920s, electric signs, painted billboards, voices on the radio, and newspaper advertisements were used to attract buyers. The ads became bigger, bolder, and more persuasive and a major industry was established to deal with the increased demand for this service. When new media, such as television, came into being, the advertising industry expanded into these areas as well.

In today's highly competitive society, billions of dollars are spent each year by American industries in an attempt to get consumers to choose one product over another. Any company hoping for success must allocate funds for this purpose.

INTRODUCTION TO TECHNOLOGY TECHNOLOGY LEARNING ACTIVITY

CHOOSING RESOURCES THROUGH MATERIALS TESTING

MODULE NUMBER: T-6
NUMBER OF DAYS: 14-24

MAJOR CONCEPTS TO BE ADDRESSED

T-6A Resources used in solving technological problems are chosen from each of the seven resource categories.

T-6B In choosing resources, a broad familiarity with available resources and their properties is necessary.

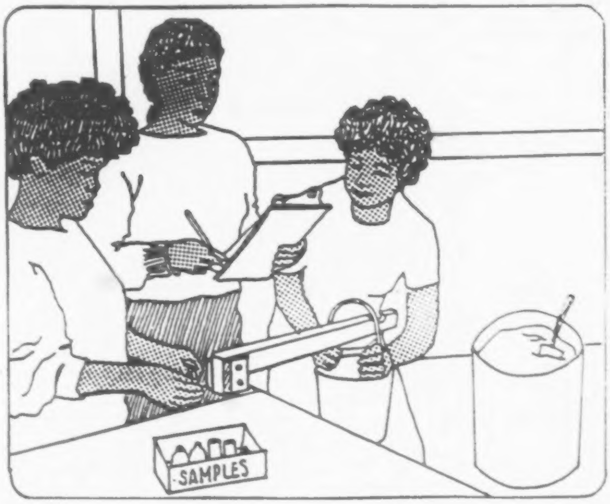
T-6C Resources are tentatively chosen in the early stages of technological problem solving based upon identified goals.

T-6D Important factors in choosing resources are availability, cost, and appropriateness.

T-6E Information, a resource that includes numbers, graphics, and words, can be accessed through the use of computers.

T-6F In choosing resources, human and natural constraints and limitations must be considered.

T-6G Optimization, the process of choosing the best combination of resources to solve a problem, often requires compromises and tradeoffs.



OVERVIEW OF TLA

Students will develop the ability to choose resources based upon set criteria. These criteria may include such aspects as safety, cost, appropriateness, properties, and environmental considerations. In choosing resources, human and natural constraints must be considered.

Through experimentation and testing, students will investigate properties of various resource materials. These tests will also include information accessed through the use of a computer.

EQUIPMENT AND SUPPLIES

- Testing devices (see Appendix)
- Tools and machines to prepare samples to be tested
- A variety of materials (wood, metal, plastic, ceramic, textiles) at each test station or a bag of like materials for each student team
- Data recording sheet (see Appendix)
- Safety equipment
- Computer hardware and software

PROCEDURE FOR THIS ACTIVITY

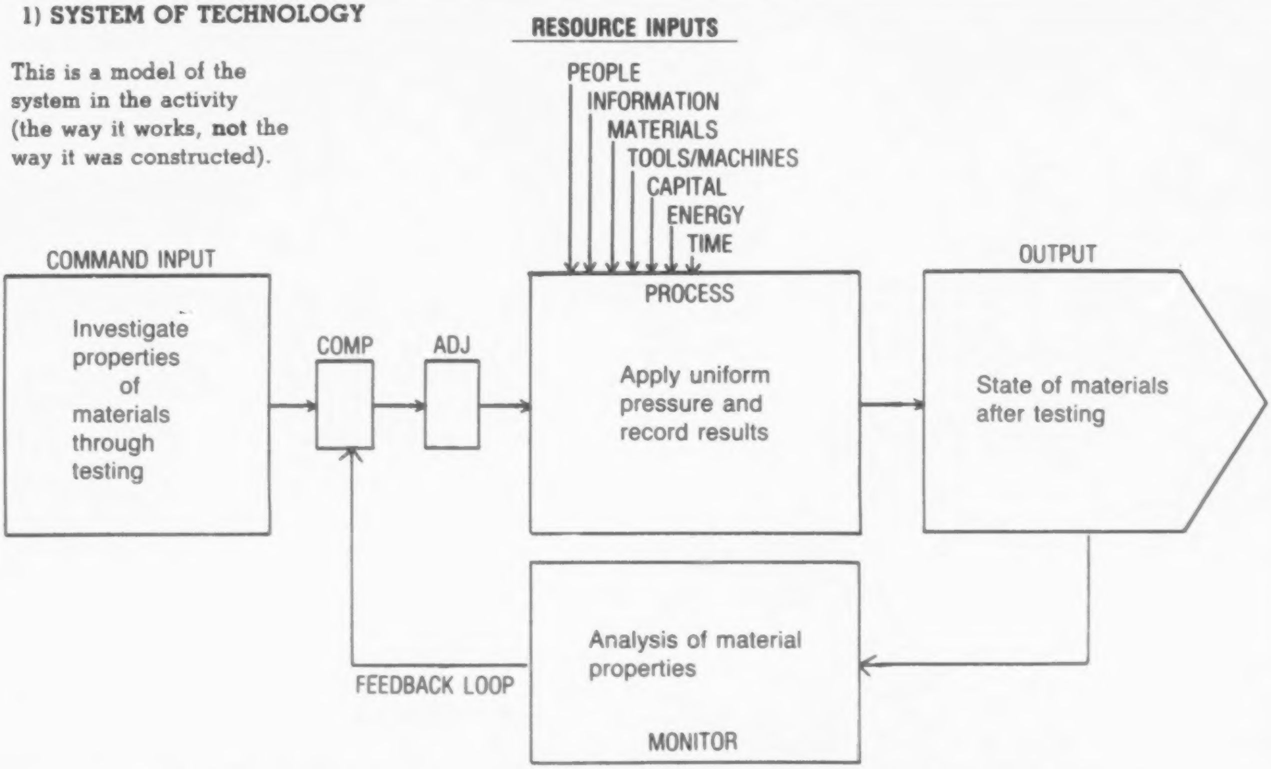
Days	POs*	Teacher Activity	POs*	Student Activity
2	PO2 1a 1b	Review the seven resources for technology and how they are required for any technological system to function. Conduct discussion about how alternative resources can be used to achieve the desired goal. Give a problem situation in each of the three aspects of technology.	1a 1b 1c 1d	Identify the seven resources necessary in each problem situation using research materials from lab or school library. In conducting the research, analyze the alternative resources and determine the most promising.
2	2b	Discussion of materials testing to include the following questions: Why test? What properties can we test? How do we test materials?		
		Demonstration of how various materials testing devices are used. Include synthetic, raw, and biological materials.	2a	Identify materials to be tested as to which group they fall into: synthetic, raw, or biological.
			2b	Determine which testing method or device will be used for each material.
		Demonstrate tools and machines needed to prepare samples to be tested.		Use tools and machines to prepare samples.
7-17		Discussion of safety practices for materials testing.	2c 2d	Perform materials tests. Record and evaluate each test on the basis of the properties observed.
	2b	Assist students with materials testing applications.	PO2	
		Discuss how a functioning system can be changed or optimized by substituting different resources.	3a 3b 3d 3f	Using a functioning system such as a vacuum (Thermos) bottle, compare various types of bottle liners (glass, metal, plastic) for heat loss characteristics.
2		Demonstrate use of the Science Tool Kit, temperature probe hardware and software.	4a, 4b 4c	Use a computer and Science Tool Kit software.
			3c 3e PO3 PO4	From the data gathered, determine appropriateness of each type of vacuum bottle versus its cost and heat loss effectiveness.
1		Review and administer a test on the objectives of Module T-6.		Take examination on Module T-6.
14-24 Total Days				

*See Syllabus for phrasing of performance objectives and supporting competencies.

CONSTANTS FOR INFUSION INTO THE TLA

1) SYSTEM OF TECHNOLOGY

This is a model of the system in the activity (the way it works, **not** the way it was constructed).


RESOURCE INPUTS
PEOPLE
INFORMATION
MATERIALS
TOOLS/MACHINES
CAPITAL
ENERGY
TIME
COMMAND INPUT
Investigate properties of materials through testing
COMP
ADJ
PROCESS
Apply uniform pressure and record results
OUTPUT
State of materials after testing
Analysis of material properties
MONITOR
FEEDBACK LOOP

IDENTIFY THE ROLE OF THE FOLLOWING RESOURCES IN THE SYSTEM ABOVE:
PEOPLE, INFORMATION, MATERIALS, TOOLS & MACHINES, CAPITAL, ENERGY, TIME.

2) MATH - Students will measure and cut samples and weigh loads. They will calculate the average (mean) for a group of tests and chart and graph data collected. They will use formulas to calculate specific variables.

3) SCIENCE - Principles of classes of levers. Students will study and follow directions for adhesive application. They will make comparisons of materials based on their properties. All substances have special physical properties. These properties include melting and freezing points, tenacity, ductility, malleability, elasticity, brittleness, hardness, color, and conductivity. Levers may be classified according to the relative position of the fulcrum, effort force, and resistance force. The ideal mechanical advantage of a lever can be determined by dividing the length of the effort arm by the length of the resistance arm. See Appendix: Testing Devices.

4) HUMAN & SOCIAL IMPACTS - Students will learn that standards for materials are necessary for proper use of technology in society. The lack of safety features in early mining and manufacturing industries led to numerous incidents involving the workers. Current safety standards in American industries should be reviewed and areas noted where improvements still need to be made for the protection of the labor force.

5) COMMUNICATION SKILLS - Students will show data and results in charts and graphs. They will read and follow information. They will learn vocabulary relating to materials testing and properties.

6) SAFETY AND HEALTH - Students will comply with all safety regulations as determined by a participatory program of safety rules for laboratory work.

7) PSYCHOMOTOR SKILLS - Students will develop or improve manual dexterity along with eye-hand coordination while preparing samples and doing tests.

8) CAREER RELATED - Students will be exposed to methods used by engineers, technologists, lab technicians, metallurgists, as they explore methods of testing different properties, make observations and measurements, and record data. Evaluation of comparisons should provide for higher levels of learning and perhaps discovery.

9) CREATIVE PROBLEM SOLVING - Opportunities for creative problem solving will be provided by this TLA including: identification and definition of a problem, goal and criteria setting, generation of alternative solutions and recognition of limitations, optimization, testing, and evaluation.

10) TRANSFER OF LEARNING - Students will analyze data from different tests. Students will learn methods of calibrating a scale with known measurements compared with unknown. Students will design tests for some unknown materials. They will be able to design different test types and the specialized equipment needed to perform them.

BACKGROUND REFERENCES AND RESOURCES

Science Tool Kit:
Broderbund Software
17 Paul Drive
San Rafael, CA 94903-2101

Hacker, M. and Barden, R. *Technology in Your World.* Albany, NY: Delmar Publishers, 1987

Todd, R., McCrory, D., and Todd, K. *Understanding and Using Technology.* Worcester, MA: Davis Publications, 1985.

EVALUATION

The teacher should develop a two component evaluation system to determine if the student understands: (1) performance objectives and (2) skills, attitudes, knowledge & safety related to the specific lab activity.

(1) EVALUATION OF PERFORMANCE OBJECTIVES (Examples)

1. List the seven resources of technology. 1a

2. Wood, cotton, and wool are examples of which type of material? 1b
    A. Synthetic
    B. Biological
    C. Fossil
    D. Non-renewable

3. Define the term optimize as it applies to the selection of resources. PO3

(2) EVALUATION OF SKILLS, ATTITUDES, KNOWLEDGE & SAFETY (Examples)

1. When the red indicator "Disk in use" light of the computer is on you should
    1. Remove the disk
    2. Turn off the computer
    3. Start the printer
    4. Wait until it goes off

2. Clarity and reflectivity are examples of which material property?
    1. Thermal
    2. Mechanical
    3. Optical
    4. Magnetic

3. Any material that can be twisted, bent, or pressed into shape has a high
    1. Ductility
    2. Elasticity
    3. Plasticity
    4. Reflectivity

APPENDIX: DATA RECORDING

MATERIAL TESTING

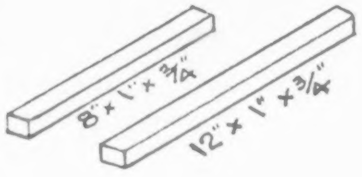
STUDENT TEAM

1 ______________ 3 ______________

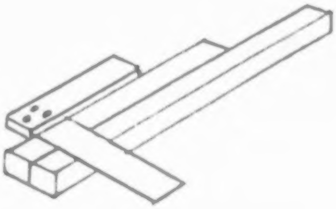
2 ______________ 4 ______________

Test Type	Material Tested	Test Results	Average	Remarks
TENSILE				
HARDNESS				
ADHESION				
ABRASION				
COMPRESSION				

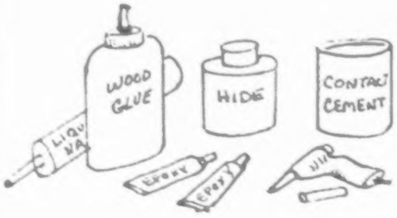
APPENDIX: EXPERIMENT


8"x1"x3/4"
12"x1"x3/4"

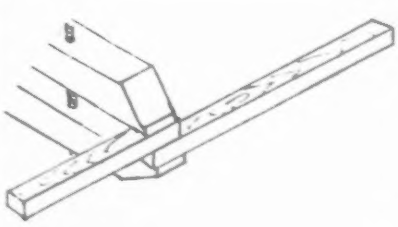
Cut wood samples to size ①



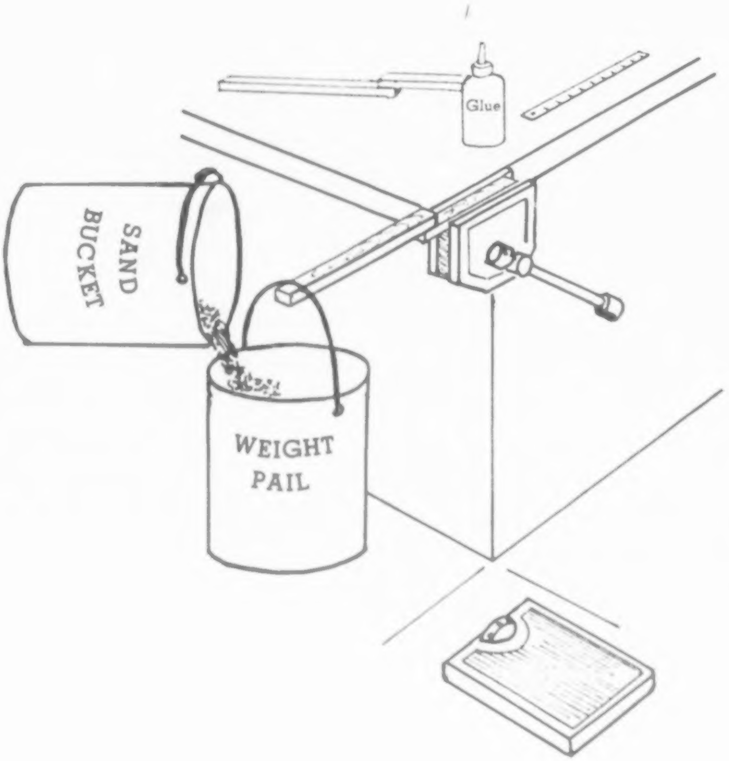
Measure 1"sq. contact surface ②


WOOD GLUE
HIDE
CONTACT CEMENT
EPOXY
EPOXY

Select an adhesive to test ③



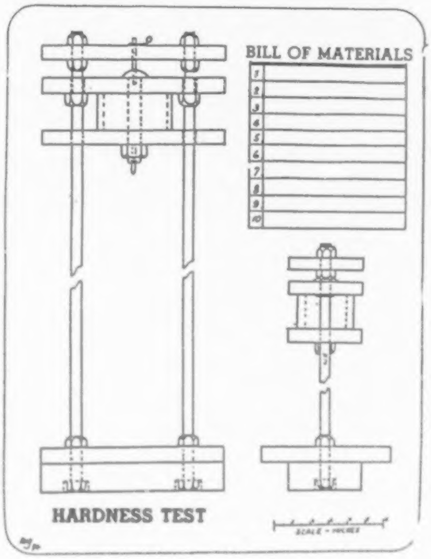
Follow gluing instructions ④


Glue
SAND BUCKET
WEIGHT PAIL

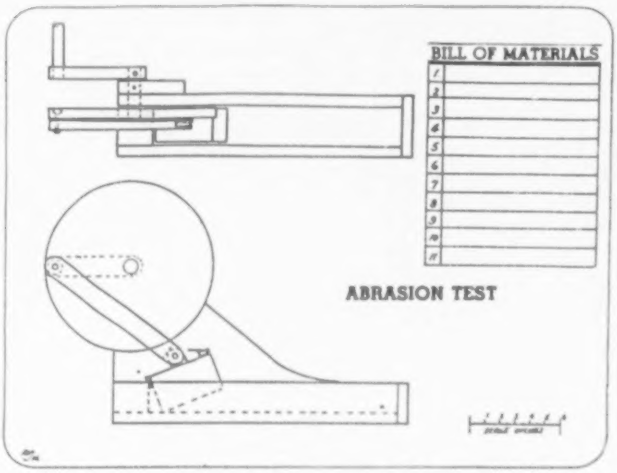
ADHESION TEST

Load weight bucket slowly until glue joint breaks. Weigh the load. Calculate the real load. Chart data. Compare results

APPENDIX: TESTING DEVICES


BILL OF MATERIALS
1
2
3
4
5
6
7
8
9
10
SCALE - INCHES

HARDNESS TEST


BILL OF MATERIALS
1
2
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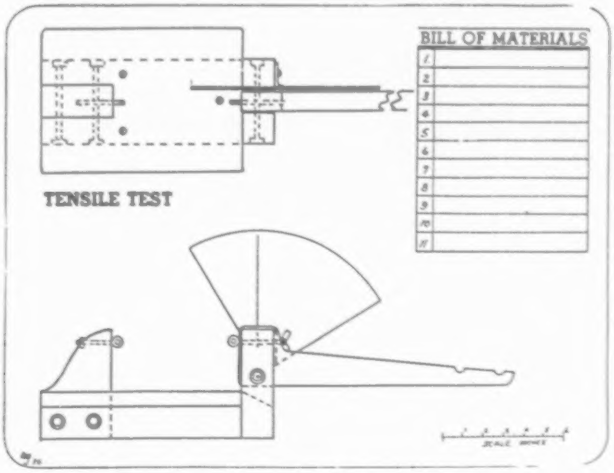
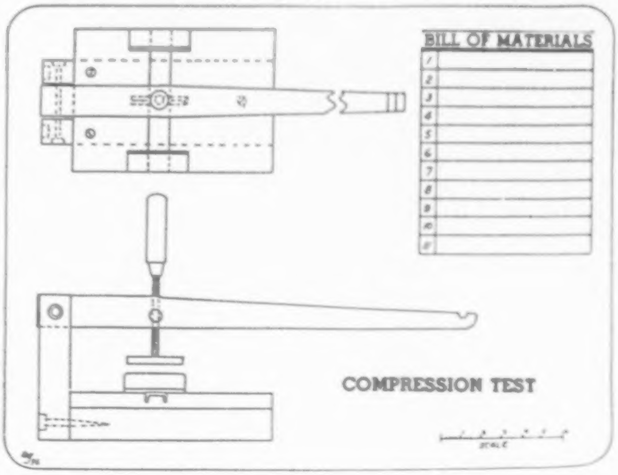
7
8
9
10
11

ABRASION TEST


BILL OF MATERIALS
1
2
3
4
5
6
7
8
9
10
11
SCALE - INCHES

TENSILE TEST


BILL OF MATERIALS
1
2
3
4
5
6
7
8
9
10
11
SCALE

COMPRESSION TEST

NOTE: Other types of materials tests are those which test electrical and thermal conductivity; magnetic and optical characteristics; and products such as electronic components and fishing line (to compare manufacturers' ratings with actual values).

APPENDIX: ADDITIONAL SCIENCE AND SOCIAL SCIENCE CONCEPTS

Science

Matter has physical and chemical properties which help to identify it. Physical properties can be examined without changing the chemical composition of the substance. The types and arrangement of atoms account for these properties. Some physical properites:

1. Boiling point and condensation point are the temperatures at which a substance changes from liquid to gas or gas to liquid.
2. Melting point and freezing point are the temperatures at which a substance changes from solid to liquid or liquid to solid.
3. Elasticity is the ability of an object to stretch and return to its original position.
4. Color is the way an object absorbs and reflects light.
5. Luster is the shininess of a material.
6. Density is the mass in grams of an object divided by its volume in milliliters or cubic centimeters. The density of homogeneous objects is uniform at constant temperature and pressure. Increasing the temperature at a constant pressure tends to reduce the density by speeding up and therefore separating molecules in the material. Increasing pressure at constant temperature tends to increase density by pushing the molecules closer together.
7. Tenacity refers to the ability of a substance to resist being pulled apart. Tenacity is related to the chemical bonds holding the atoms together. Materials with a high tenacity, like steel, resist being pulled apart.
8. Malleability is a property of most metals which lets them be rolled into sheets like aluminum foil or pounded into different shapes. Ductility is a property of metals which allows them to be drawn into wires. Metals are malleable and ductile because of the nature of the metallic bonds holding the atoms of metals together. The bonds consist of positively charged metal ions surrounded by a sea of negatively charged electrons. The metal is held together because all of the positively charged nuclei share all of the negatively charged electrons. Therefore if a metal is hammered, the positively charged nuclei move past each other without breaking the metallic bonds because they share all of the electrons.
9. Conductivity refers to a material allowing heat or electricity to pass through it. Metals are good conductors of electricity because of the nature of the metallic bond. The electrons in metals are free enough to move through the metal. Metals are also good heat conductors because the closely packed particles in the metal are free to bump into each other, increasing the movement of particles. Fast moving particles are at higher temperatures than slow moving particles.
10. Brittleness is the ease with which a substance breaks. Brittleness has to do with the arrangement of atoms. Metals are not brittle because metallic ions in layers can slide over each other without shattering crystalline structure.
11. Hardness refers to resistance to being scratched. Hardness is related to the arrangement of atoms in a material. For example, diamond, the hardest known natural element, and graphite, the "lead" in a pencil, are both composed of carbon atoms. The difference is that the bonds holding carbon atoms together in diamonds are three-dimensionally strong covalent bonds. Each carbon atom is bonded covalently to four other carbon atoms. In graphite each carbon atom is bonded covalently to three other carbon atoms in the same plane. This is a two-dimensionally strong bond. Graphite carbon planes slide easily over each other, thus making graphite a good lubricant.

Source for some ideas: Koenig, Herbert, DeMarco-Keating, Mary Lou, and Lansing, Janet. *NYS-RCT Science Review*. Middletown, New York: N & N Publishing Company, 1987.

APPENDIX: ADDITIONAL SCIENCE AND SOCIAL SCIENCE CONCEPTS (Continued)

Social Science

With industrialization in the late 1800s, workers' output increased but many times at the expense of safe working conditions. A six-day work week of 10 hours per day was not uncommon, leading to fatigue and subsequent accidents. Working conditions were unhealthy or even dangerous. Garment workers were forced to work in crowded, dirty tenements, and factories often were characterized by poor lighting, heating, and ventilation. Those toiling in the coal mines — many times children seven and eight years old — were subjected to coal dust, unsafe machinery, and avalanches of coal.

The labor movement (unionization) was one response to these circumstances. Workers organized in an attempt to obtain shorter hours, higher pay, and safer working conditions. Through these efforts, and eventually government intervention, safety measures were instituted which made for a better and safer work place.

Today, safety standards are still a concern for American industry and the protection of the labor force continues to command the attention of the American people. Conditions in the work place have improved, but now such things as nuclear power plants and hazardous waste products create new, potentially dangerous situations requiring attention.

INTRODUCTION TO TECHNOLOGY TECHNOLOGY LEARNING ACTIVITY

FOOD PROCESSING

MODULE NUMBER: T-7
NUMBER OF DAYS: 14-22

MAJOR CONCEPTS TO BE ADDRESSED

T-7A Technological systems convert resources into end products which become new forms of energy, information, and/or materials.

T-7B The conversion of resources is usually directed by humans who develop technological systems.

T-7C The actual conversion of resources occurs within the process component of a technological system.

T-7D The results of conversion processes within a technological system should be monitored and the processes adjusted if the command input and system output are to match one another.

T-7E Computers as tools are used for information processing, communication, and system control.

OVERVIEW OF TLA

Students will design and construct a dryer or cooker, as a device for processing food. This device will serve as an example of how resources are converted into new forms. Students will process information in order to advertise the product. The conversion processes will change materials by using energy that is directed and monitored by humans and/or machines. Although many of the food preservation methods are commercialized and automated (e.g., freeze drying), it will become evident to the student that humans are involved in their design and are the benefactors of the processes. Computers will be used for information processing and/or systems control. Examples of food preservation devices and techniques include using solar energy, light bulb, fan, hickory smoker, or salting.

EQUIPMENT AND SUPPLIES

- Tools and machines to construct various food processing systems
- Computer hardware and software
- Moisture sensors
- Hickory smoker
- Commercial or student-made food dryer
- Fan
- Telecommunication equipment
- Graphic reproduction equipment
- Mylar or acrylics
- Sheet metal and wood
- Sulfur dioxide (used to retain color and soften texture)

PROCEDURE FOR THIS ACTIVITY

Days	POs*	Teacher Activity	POs*	Student Activity
2	1a 1b	Ask students to give examples of food preservation techniques that have been developed over the years. These may include salt and sugar curing, pickling, pasteurizing, freezing, drying, irradiating, and refrigerating. Identify foods that use these techniques.	1c	Describe the effects of food processing and additives and preservatives on nutrients, palatability, and market acceptance. Brainstorm to identify which foods can be preserved by which method. Choose food preservation processes to be explored. Identify seven resources needed. Identify inputs and outputs.
	1c	Introduce material conversion processes of addition, separation, contour change, and internal change. Demonstrate how traditional materials (wood, metal, plastics, ceramics) use these conversion processes.	1b 1c	Describe the nature of the material change and the output that results from the conversion process.
		Explain how food processing involves material conversion. Cutting food is a separation process. Cooking involves addition and internal change. Jello making involves contour change. Most food preservation processes involve internal change because bacterial growth is inhibited. Introduce activity which involves constructing a device for processing food.	1a	Categorize processes into traditional and modern conversion processes.
1		Provide information resources (books, pictures, plans, models) relating to food processing devices. These devices may include dehydrators, solar cookers, smokers, ice-boxes, etc.		
	1d 1c	Demonstrate safe use of tools and machines to be used in construction of food processing device. Ask students to describe nature of material change during construction.	1d PO1	Process a variety of materials and begin conversion and gathering data. (Use wood, sheet metal, steel, mylar, acrylics.)
4-8		Facilitate construction of device for food processing.	PO1	Sketch alternative designs for material processing device. Draw plans for device to be produced. Submit plans for dehydrator, cooker, solar dryer, or other processing device. Construct device.
1-4	2b 2c	Give examples of how graphic, photographic, electronic, and mechanical means of communicating information have been used to advertise foods.	2a-d	Identify resources needed for the examples. Choose the system to be used and identify system inputs and outputs.
			PO2	Write an advertisement for the product being built and the directions for its use. Use communication systems chosen.

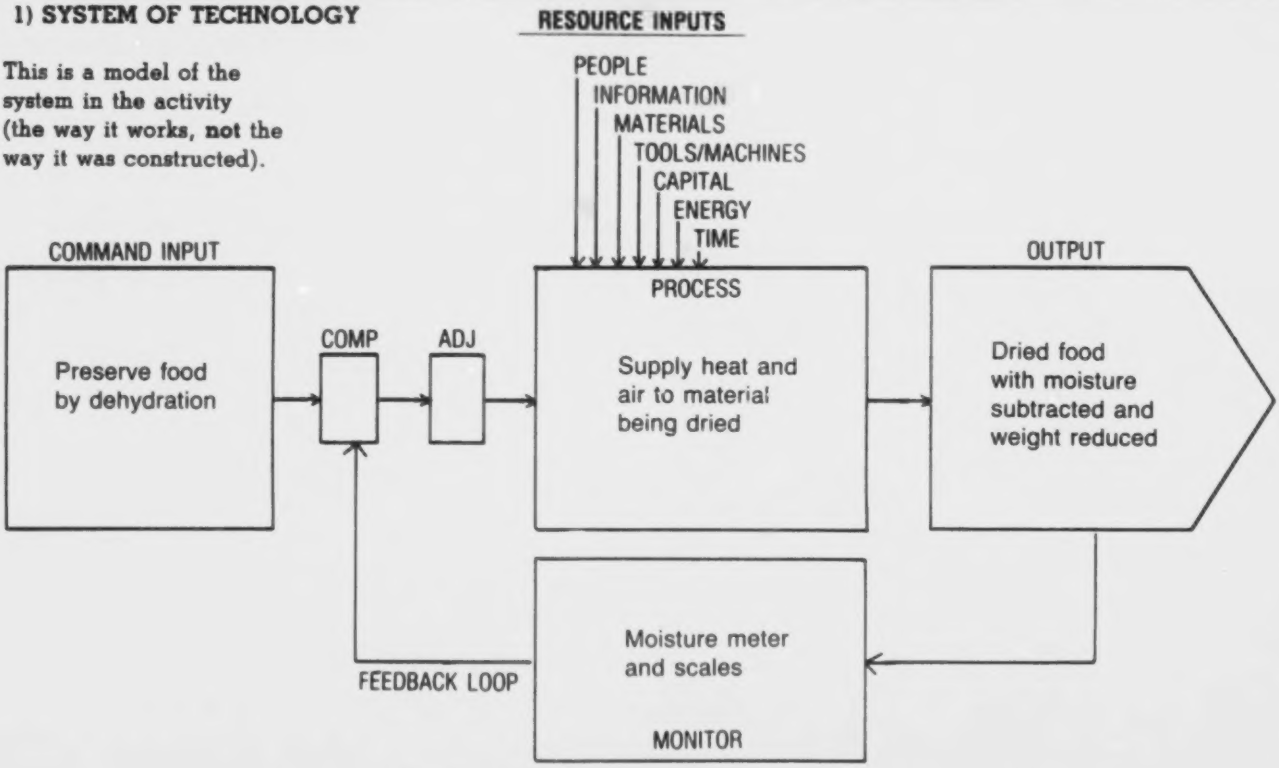
Days	POs*	Teacher Activity	POs*	Student Activity
2		Make available computer software related to energy, data processing, and communication. Demonstrate computer systems.	4a-d PO4	Define the problem of data storage and organization of materials. Identify devices that could be used to store information. Select appropriate software and operate the system. Process accumulating information regarding food preservation.
2	3a 3c	Show where energy conversion occurred within the activity chosen. Give examples of energy conversion in the three aspects of technology.	3a-c	Identify resources needed for specific energy conversion processes. Describe change and outputs. (Include three aspects of technology.)
1-2	3a-d	Demonstrate other energy conversion processes and relate to heat needed for food dehydration. Include commercial food dehydrator and hickory smoker.	3d PO3	Perform energy conversion processes in each aspect of technology. Identify energy conversion which takes place in food dehydration.
1		Check student progress.		Evaluation of knowledge.
14-22 Total Days				

*See Syllabus for phrasing of performance objectives and supporting competencies.

CONSTANTS FOR INFUSION INTO THE TLA

1) SYSTEM OF TECHNOLOGY

This is a model of the system in the activity (the way it works, not the way it was constructed).


RESOURCE INPUTS
PEOPLE
INFORMATION
MATERIALS
TOOLS/MACHINES
CAPITAL
ENERGY
TIME
COMMAND INPUT
Preserve food by dehydration
COMP
ADJ
PROCESS
Supply heat and air to material being dried
OUTPUT
Dried food with moisture subtracted and weight reduced
Moisture meter and scales
MONITOR
FEEDBACK LOOP

IDENTIFY THE ROLE OF THE FOLLOWING RESOURCES IN THE SYSTEM ABOVE:
PEOPLE, INFORMATION, MATERIALS, TOOLS & MACHINES, CAPITAL, ENERGY, TIME.

2) MATH - Students will add and subtract decimals, change fractions to decimals and decimals to percents, and read meters and scales. They will calculate changes in cylindrical volumes ($v = \pi r^2 h$) and volumes of rectangular prisms ($v = lwh$).

Calculate percent of weight loss of food:

$$\frac{\text{Beginning weight} - \text{final weight}}{\text{Beginning weight}}$$

Use correct order of operations in formulas for changing C° to F° (exponents; multiplication and/or division; addition and/or subtraction).

3) SCIENCE - Temperature, pasteurization, nutritional quality, bacteria spoilage.

Temperature Conversion

$$C^\circ = \frac{5\,(F^\circ - 32)}{9} \qquad F^\circ = \frac{9\,(C^\circ)}{5} + 32$$

Heat Loss Coefficients

Btu = (abbreviation for British thermal unit) the amount of heat needed to raise the temperature of one pound of water one degree F.

K = The amount of heat (in Btu's) transferred in one hour through one square foot of a given material that is one inch thick and has a temperature difference between its surfaces of one degree F. Called the coefficient of thermal conductivity.

C = Represents the conductance of a material and shows the amount of heat (Btu's) that will flow through the material in one hour per square foot of surface with one degree temperature difference.

R = Represents the resistivity or resistance which is the reciprocal of conductivity or conductance. A good insulation material will have a high R value. $R = \frac{1}{K}$ or $\frac{1}{C}$

4) HUMAN & SOCIAL IMPACTS - Shipping of foods to far places. Need for immediate preparation of foods. Variety of foods - TV dinners, home delivery of prepared foods, microwave meals.

5) COMMUNICATION SKILLS - Writing "directions for use." Explaining technical problems associated with construction and use of equipment.

6) SAFETY AND HEALTH - As related to handling power and hand tools, chemicals, and heat sources. Nutrition value, bacteria spoilage. Associated hazards of canning, freezing, drying, salting, and pickling. It is suggested that food used for this TLA not be eaten.

7) PSYCHOMOTOR SKILLS - Using hand tools and power tools; keyboarding.

8) CAREER RELATED - Food processing/food science industry, microbiology, lab technician.

9) CREATIVE PROBLEM SOLVING - Opportunities for creative problem solving will be provided by this TLA including: identification and definition of a problem, goal and criteria setting, generation of alternative solutions and recognition of limitations, optimization, testing and evaluation.

10) TRANSFER OF LEARNING - Apply knowledge to varied situations and lifestyles. Food for space, ocean cruising, back packing, bicycling.

BACKGROUND REFERENCES AND RESOURCES

REFERENCES

Garrison, Joseph. *Solar Projects*. 1981. Running Press, 125 South Twenty-second St., Philadelphia, Penn. 19103.

Hacker, Michael and Barden, Robert. *Technology in Your World*. Albany, NY: Delmar Publishers, 1987.

Todd, R., McCrory, D. and Todd, K. *Understanding and Using Technology*. Worcester, MA: Davis Publications, 1985.

Tooley, Peter. *Food and Technology*. Hart-David Education Garden Way Books.

RESOURCES

County Cooperative Extension Agent as a resource person.
Burpee Company - Food dryer.
L.L. Bean - Country Smokehouse.

EVALUATION

The teacher should develop a two component evaluation system to determine if the student understands: (1) performance objectives and (2) skills, attitudes, knowledge & safety related to the specific lab activity.

(1) EVALUATION OF PERFORMANCE OBJECTIVES (Examples)

1. Name the resources that were needed in your energy conversion process. 3a

2. List some energy conversion processes found in each aspect of technology. 3c

3. Describe the process of information change and the outputs that result from a radio communication system. 2c

4. List safety procedures that should be observed when processing metal, wood, or plastics. 2d

5. Why do we rely on electricity for most of our energy needs? 3b

6. Why do we rely on the internal combustion engine for transportation? 3b

(2) EVALUATION OF SKILLS, ATTITUDES, KNOWLEDGE & SAFETY (Examples)

1. What would be the impact if for some reason we could no longer dry food today? In the 1700s?

2. Make a list of the desired, undesired, expected, and unexpected outputs of food drying processes.

3. Compare food drying processes of the 1700s to the processes that are used today.

4. Make a list of foods that are still being dried today.

5. List some assembly procedures used in building your drying devices.

APPENDIX: FOOD DRYING IDEAS

To dry food effectively in the sun, three components are needed: heat, free circulation of air, and protection from insects. Solar food dehydrators should use reflective side panels to concentrate the sun's rays inside the box to generate heat. The dehydrator is essentially a flat-plate collector with a transparent cover, black absorber plate, and a storage rack inside to hold fruits or vegetables for drying. With a small breeze, air circulates through the front and back vents to eliminate moisture inside the box. The vent holes are small to inhibit insect infestation; they may have to be enlarged later and covered with cheesecloth for protection against insects if no air movement is occurring. The main body should be insulated to prevent heat loss if the required 135° to 150° temperature is not reached.

Solar food dehydrators should be used on bright, sunny days with a slight breeze blowing. Sometimes the food is blanched before drying to loosen the fibers, remove bad odors, and obtain more uniform evaporation of moisture in the drying process. A cookbook should be consulted for complete instructions and blanching times for vegetables. Some basic guidelines used for solar food dehydration are as follows:

1. Keep the food dehydrator pointed toward the sun at all times.
2. Keep the food items separated while they are inside the dehydrator; this allows air to circulate freely around the food.
3. Wash and slice the fruits and vegetables into thin strips for best results.
4. Turn the drying food at least twice a day.
5. Take the food inside at night or during cloudy weather.
6. Do not exceed temperatures of between 135° and 150° F for extended periods of time.
7. If insects are getting inside the dehydrator, enlarge the vent holes and cover them with cheesecloth.
8. As a precautionary measure to prevent insect eggs from being hatched, the dried food can be conventionally heated to 180° F for 5 to 10 minutes.
9. Use discretion when eating the food. Make sure food has not been contaminated.

APPENDIX: ADDITIONAL SCIENCE AND SOCIAL SCIENCE CONCEPTS

Science

Certain harmful microorganisms can spoil food. Microorganism growth can be inhibited in the following ways.

1. Pasteurization involves heating and suddenly chilling a material such as milk. This process kills dangerous germs and inhibits the growth of bacteria which sour the milk.

2. Canning first kills bacteria by heating food to high temperatures. Then sealing the container air tight keeps out bacteria and oxygen.

3. Drying removes water. Bacteria cannot grow without water.

4. Preservatives prevent the breakdown of a food by bacteria.
   a. Salt curing provides a salty environment in which bacteria cannot live. Salt causes water to be drawn out through cell membranes.
   b. Pickling adds acids, like vinegar, to food. Microorganisms cannot live in high acid concentrations.
   c. Sugaring reduces the amount of moisture for microorganisms.
   d. Smoking helps destroy microorganism growth. Generally, the smoke comes from burning wood.

5. Ultraviolet radiation is a form of electromagnetic radiation which is effective in killing many types of bacteria. It can even destroy some bacteria not destroyed by boiling.

6. Refrigeration lowers the temperature of food, thus inhibiting bacteria growth. Generally, chemical reactions proceed more slowly at lower temperatures.

7. Freezing stops the growth of microorganisms without killing them.

Source for some ideas: Koenig, Herbert, DeMarco-Keating, Mary Lou, and Lansing, Janet. *NYS-RCT Science Review.* Middletown, New York: N & N Publishing Company, 1987.

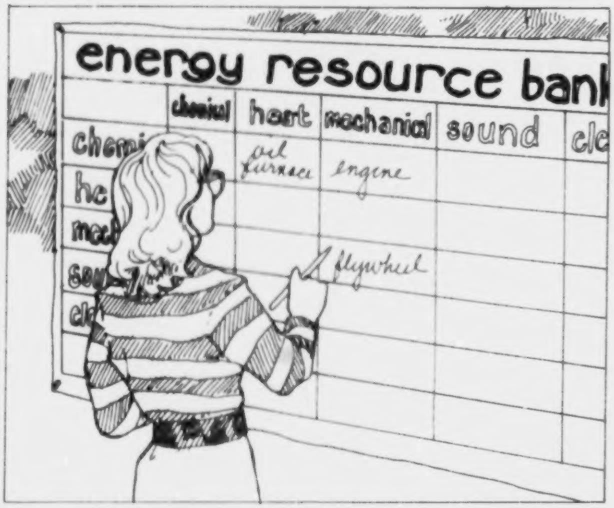
Social Science

Transporting agricultural products over long distances was a problem that confronted producers for many years. By the early 1800s, a network of roads, canals, and railroads was in various stages of development in the United States which would allow for the shipment of food stuffs more rapidly to consumers across the nation. However, spoilage was still a problem and the distribution of some food products was still severely restricted to certain geographic areas.

These restrictions have been gradually eliminated through continued developments in the transportation and food processing industries. People throughout the world can now receive items grown and processed in other parts of the world. Inventions such as the automobile, airplane, and refrigerated trucks, when combined with freezing of foods, use of preservatives, and other procedures for retarding spoilage, enable food manufacturers to distribute their products to distant markets. Fish caught off the coast of Massachusetts in the morning can now be served for supper in Japan.

INTRODUCTION TO TECHNOLOGY
TECHNOLOGY LEARNING ACTIVITY

ENERGY PROCESSING: BUILDING AN ENERGY RESOURCE BANK



MODULE NUMBER: T-7
NUMBER OF DAYS: 15-25

MAJOR CONCEPTS TO BE ADDRESSED

T-7A Technological systems convert resources into end products which become new forms of energy, information, and/or materials.

T-7B The conversion of resources is usually directed by humans who develop technological systems.

T-7C The actual conversion of resources occurs within the process component of a technological system.

T-7D The results of conversion processes within a technological system should be monitored and the processes adjusted if the command input and system output are to match one another.

T-7E Computers as tools are used for information processing, communication, and system control.

OVERVIEW OF TLA

Energy — its production, consumption, and conservation — is vital for all life forms. By modeling energy conversion processes in physical, biological, and information communication technologies, students will better understand how each of the resources contributes to the modeled systems. The energy conversion processes will be studied through the systems model, which includes input, process, and output components. Computers will be used for data gathering. Students will also illustrate energy converters on a wall-mounted resource bank. Examples of modeled energy conversion devices include wind generators, solar collectors, lenses, batteries, photovoltaic cells, lasers, and glow plug engines.

EQUIPMENT AND SUPPLIES

- DC motor
- Wood, plastic, metal
- Milliammeter
- Hand tools and machines
- Lenses
- Fan
- Model solar collectors
- Batteries
- Photovoltaic cells
- Lasers
- Glow plug engines
- Wind tunnel
- Computer hardware and software
- Graphic reproduction material and equipment

PROCEDURE FOR THIS ACTIVITY

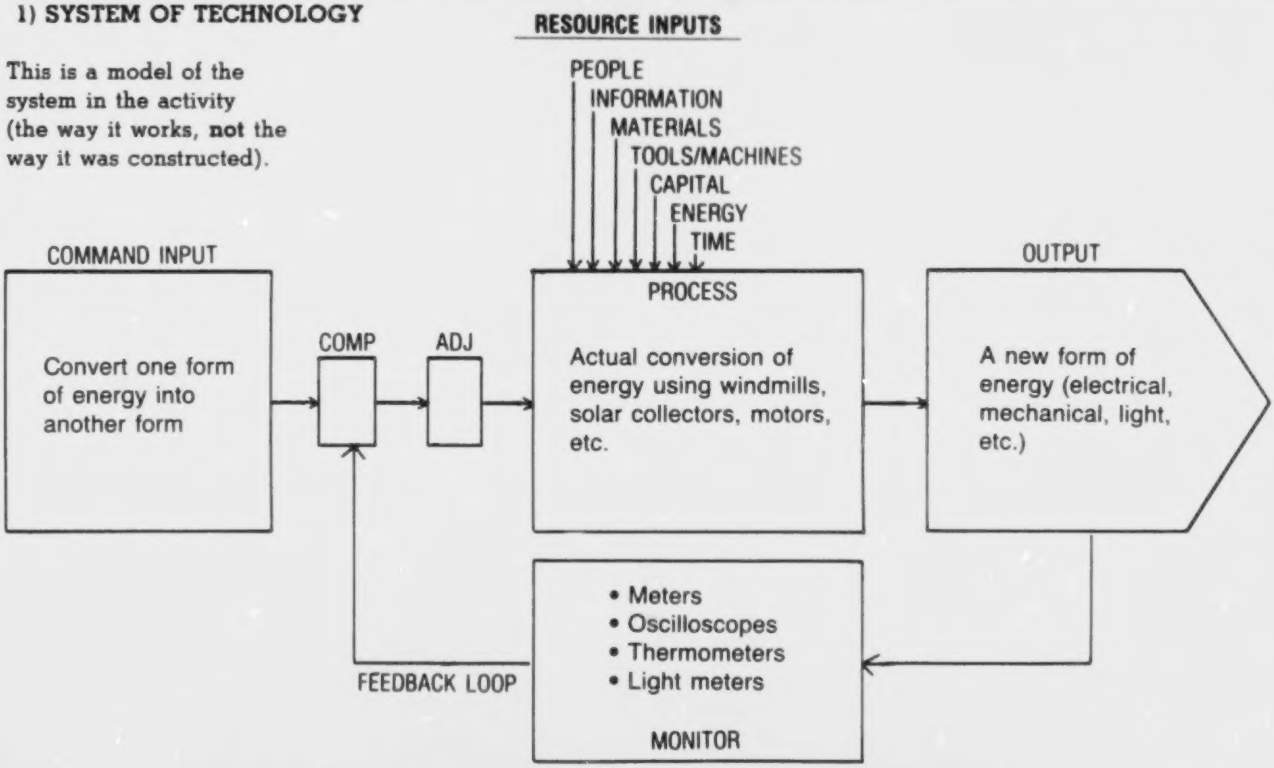
Days	POs*	Teacher Activity	POs*	Student Activity
1	1a-c	Discuss the need for energy and its direct relation to society. Give examples of traditional and modern material and energy conversion processes. Give examples of processes where energy is used to convert materials. Emphasize energy forms used.	1a-c	Give examples of traditional and modern material conversion where energy is used as a resource. Use systems diagrams. List other resources used. As homework, find other examples of traditional and modern material conversion processes.
2	3b 3c	Discuss forms of material conversion in the three aspects of technology. Include energy processes to be modeled.	3a-c	Identify resources needed, energy change, and outputs for specific energy conversion processes. Cover the three aspects of technology. Use systems diagrams.
5-8	1d 3d	Demonstrate safe use of lab equipment. Propose ideas of energy conversion to be modeled. Choose as many examples as facilities allow.	3d 4a 1d PO1	Define the problem (to convert energy from one form to another). Use a formal problem-solving method. List resources. Perform material conversion while beginning to model and build energy conversion devices.
2-4	PO1	Provide additional experiments so that students understand that materials, like energy, are resources to be processed (addition, separation, contour change, internal change). Provide a wall or bulletin board to serve as an Energy Resource Bank (see chart in Appendix).	PO1 PO3	Perform material conversion processes. Organize and collect data. Prepare illustrations for Energy Resource Bank.
1-2	4b 4c	Introduce the computer as a data source and show how it might be used for making more informed decisions. Introduce software programs dealing with energy, information, and material conversion.	4b-d PO4	Select appropriate software. Operate the computer and process the information in order to assist in making decisions about energy, information, and material conversion.
1-2		Facilitate testing and data collection of the output of energy conversion devices built by students and other examples you provide.	PO3 PO4	Test, modify, and record results of energy conversion processes. Use computers to collect data.
1-3	2a-c	Provide lessons on communicating the recorded data using graphic, photographic, and electronic means. Demonstrate telecommunications and/or networking.	2a-c	Identify resources, information change, and outputs of the system. Use systems diagrams. Develop illustrations and models for Energy Resource Bank.
1-2		Demonstrate safe use of devices used to process information and communicate messages (graphic, photographic, electronic, or mechanical).	2d PO2	Communicate the data through the use of computers, telecommunications, graphics, or mechanical means. Produce advertisements, charts, pictures, directions, or energy data.
1		Check progress. Give exam.		Take exam.
15-25 Total Days				

*See Syllabus for phrasing of performance objectives and supporting competencies.

CONSTANTS FOR INFUSION INTO THE TLA

1) SYSTEM OF TECHNOLOGY

This is a model of the system in the activity (the way it works, not the way it was constructed).


RESOURCE INPUTS
PEOPLE
INFORMATION
MATERIALS
TOOLS/MACHINES
CAPITAL
ENERGY
TIME
COMMAND INPUT
Convert one form of energy into another form
COMP
ADJ
PROCESS
Actual conversion of energy using windmills, solar collectors, motors, etc.
OUTPUT
A new form of energy (electrical, mechanical, light, etc.)
• Meters
• Oscilloscopes
• Thermometers
• Light meters
MONITOR
FEEDBACK LOOP

IDENTIFY THE ROLE OF THE FOLLOWING RESOURCES IN THE SYSTEM ABOVE:
PEOPLE, INFORMATION, MATERIALS, TOOLS & MACHINES, CAPITAL, ENERGY, TIME.

---

2) MATH - Use linear measurements in customary (fractions) and metric (decimal) units. Change fractional units (drills) to decimals. Use and read meters and micrometers. Use compass and ruler to make a parabolic curve. Measure surface area of energy conversion devices. Read charts and tables. Use decimals to compare costs for fuel and for generating power.

3) SCIENCE - Ohm's law: $I = E/R$, Watt's law: $P = E \times I$, 746 watts = one horsepower. Explain amp-hour ratings of batteries. Current of cells connected in parallel is found by adding individual cell currents. Voltage of cells connected in series is found by adding the individual cell voltages. DC to AC inverters − $E \times I = E \times I$. Record temperatures in English and metric system. Efficiency of various batteries and dry cells. Krypton and halogen light bulbs versus lumens of light.

4) HUMAN & SOCIAL IMPACTS - Historically, various resources have been used to supply energy (e.g., water power, coal). Students should understand that there were environmental implications attached to the utilization of these resources. A follow-up discussion would consider potential issues related to the new methods of energy production (e.g., solar, nuclear, geothermal).

5) COMMUNICATION SKILLS - Input - following verbal directions, observations. Output - speaking, writing, drawing, demonstrating working model to class. Computer use. Develop models and illustrations for energy display.

6) SAFETY AND HEALTH - Safe use of tools and machines as well as materials. Occupational hazards - working in and around a power plant.

7) PSYCHOMOTOR SKILLS - Development of gross and fine motor skills. Development of eye/hand coordination. Development of tool and machine skills.

8) CAREER RELATED - Engineer, environment protection, maintenance and service people, researcher.

9) CREATIVE PROBLEM SOLVING - Opportunities for creative problem solving will be provided by this TLA including: identification and definition of a problem, goal and criteria setting, generation of alternative solutions and recognition of limitations, optimization, testing and evaluation.

10) TRANSFER OF LEARNING - How is electricity produced at a nuclear power plant? Compare the outputs (desired, undesired, expected, unexpected) of a hydro-electric and a nuclear power plant. Assuming we are approaching the end of our oil reserves, what can we do to slow this process? Using the technology of today, determine the relative cost of producing energy using the prime sources. Explain that the use of new devices might save energy but may not reduce cost. Fuel cost comparison (see Appendix).

BACKGROUND REFERENCES AND RESOURCES

Garrison, Joseph. *Solar Projects*. 1981. Running Press, 125 South Twenty-Second St., Philadelphia, PA 19103.

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Todd, R., McCrory, D. and Todd, K. *Understanding and Using Technology*. Worcester, MA: Davis Publications, 1985.

EVALUATION

The teacher should develop a two component evaluation system to determine if the student understands: (1) performance objectives and (2) skills, attitudes, knowledge & safety related to the specific lab activity.

(1) EVALUATION OF PERFORMANCE OBJECTIVES (Examples)

1. Give examples of material conversion processes and place them in a chart under each aspect of technology. PO1
2. Reorganize a given set of material conversion processes from traditional to modern. 1a
3. Generate a list of resources that are needed for each of the given examples of material conversion processes. 1b
4. Use graphic, photographic, electronic, and mechanical means of communicating a message on the Energy Resource Bank. 2b
5. Using systems diagrams, identify inputs and outputs that are found in the given communication systems. Give examples. 2c
6. Rank the given examples of energy conversion in order of system efficiency. 3b
7. Using systems diagrams, identify the inputs, process, resources, and outputs of energy conversion processes. 3a-c

(2) EVALUATION OF SKILLS, ATTITUDES, KNOWLEDGE & SAFETY (Examples)

1. Explain two-cycle operation of a glow plug engine. Relate each subsystem to that of a motorcycle or lawnmower.
2. How many amps of electricity are needed to operate a one horsepower bandsaw?
3. How many amps would be needed if a 12v power supply were used for the above example.
4. What is a deep cycle auto battery?
5. What are the advantages and disadvantages of series and parallel solar collectors? (heat output)
6. Give four examples of each material conversion process (addition, separation, contour, and internal change).

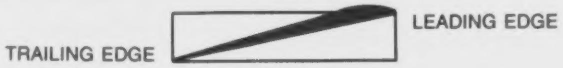
APPENDIX: ENERGY IDEAS

Lens:
Obtain a fresnel lens from a discarded overhead projector or from a supply house such as Edmund Scientific. Build a wood frame and a stand that will allow the lens to adjust from the vertical to horizontal position. Warning - Do not look at the intense white focal point except through an electric welding lens. Measure the time it takes to boil a given amount of water.

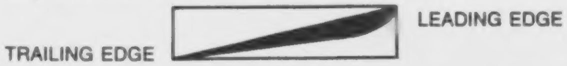
Batteries:
Use lemons and two unlike metals to produce electricity. Buy and assemble a few batteries from kits. (IASCO)

Photovoltaic Cells:
Hook the cells in parallel and series. Compare costs of using solar generated power to commercially generated electricity used in the home.

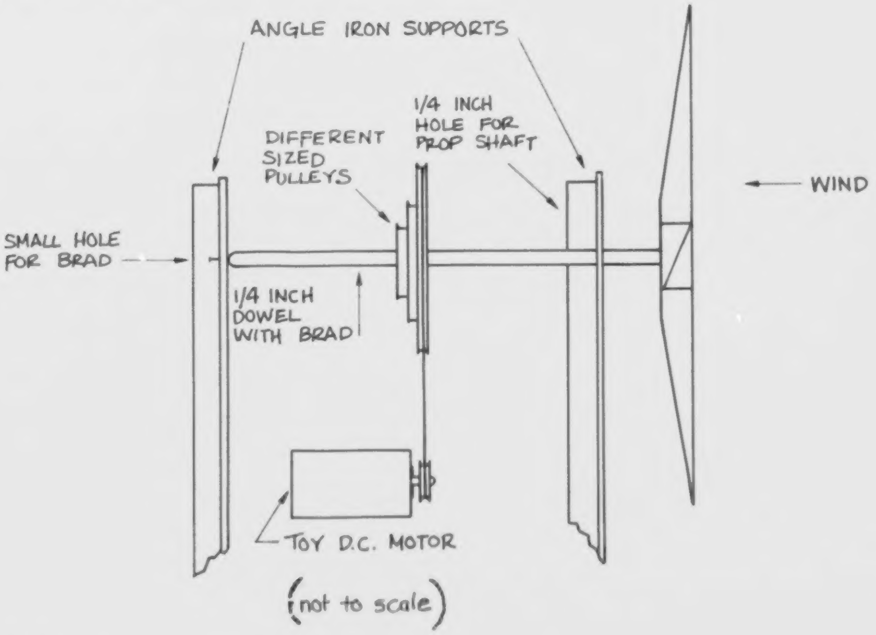
Wind Generator (compare efficiency of propeller shapes using wind tunnel):
Shape of an airplane propeller (as used on an .049 glow plug engine)


LEADING EDGE
TRAILING EDGE

Shape of a propeller for producing electricity in a wind tunnel


LEADING EDGE
TRAILING EDGE

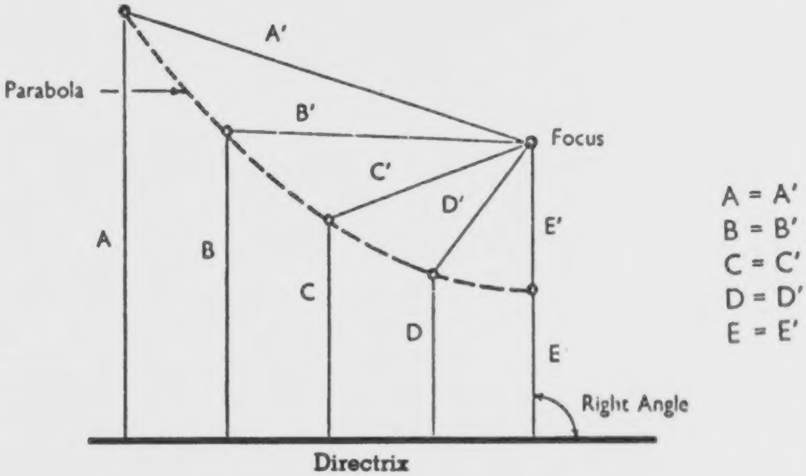
Shape the propeller and test it in a wind tunnel. Operate the propellers in both directions and compare the outputs with each other. Illustrate leading edge, trailing edge, and shape of a standard airplane propeller versus the propeller used in producing electricity in a wind tunnel.


ANGLE IRON SUPPORTS
1/4 INCH HOLE FOR PROP SHAFT
DIFFERENT SIZED PULLEYS
WIND
SMALL HOLE FOR BRAD
1/4 INCH DOWEL WITH BRAD
TOY D.C. MOTOR
(not to scale)

APPENDIX: ENERGY IDEAS (continued)

Parabolic Solar Furnace:

The history of parabolic furnaces dates back to ancient Greece. Archimedes may have performed the first major practical use of concentrated energy by burning ships in the Roman fleet. Below is the easiest method of developing a parabolic curve. The students can design the system used to support the tin plate or mylar reflector out of cardboard. A 6" wide reflector and a focal point of 6" would require approximately a 24" side.

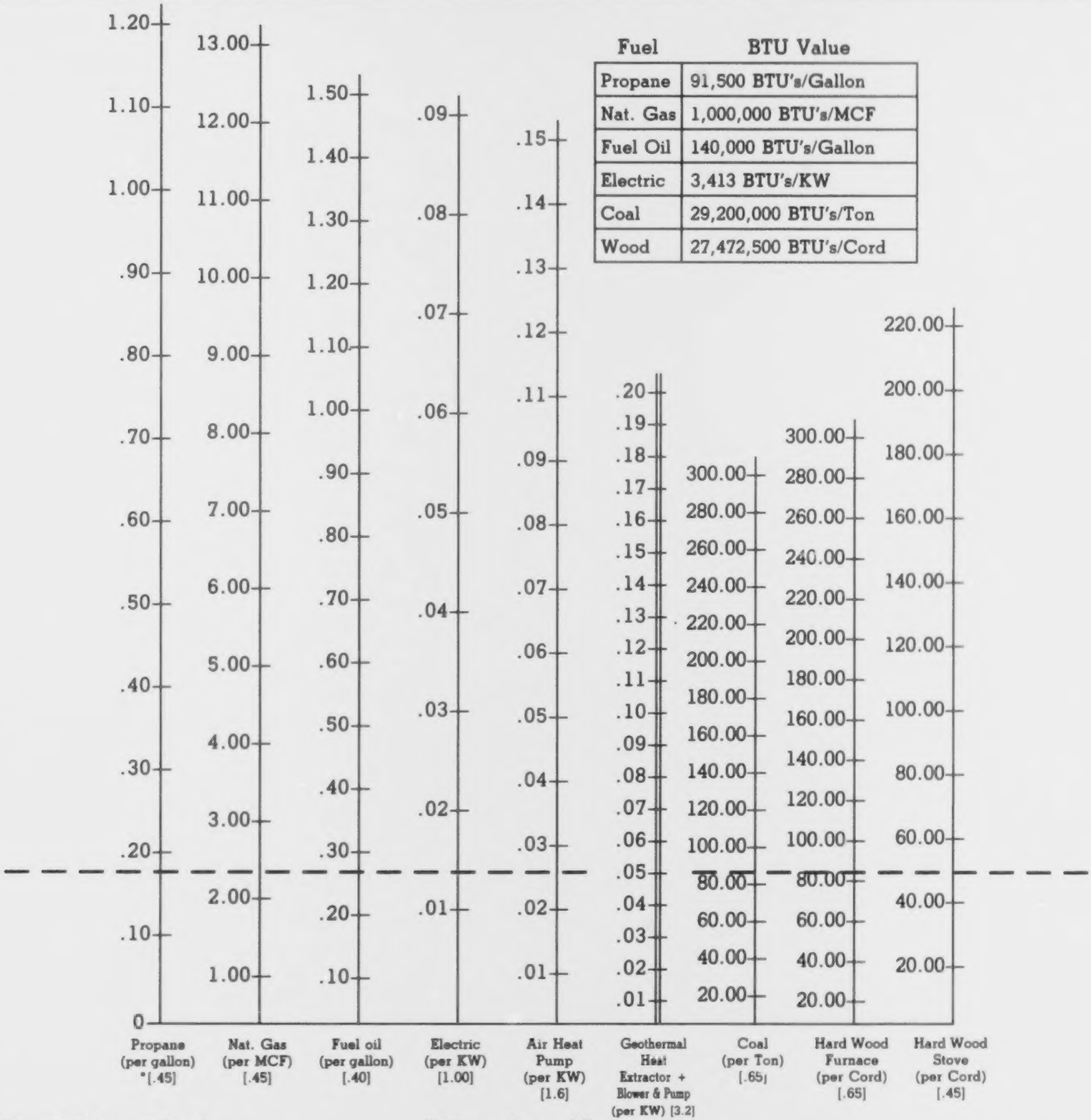


Glow Plug Engine:

Obtain a 12v electric starter for glow plug engines from a hobby supply house. Purchase a motorcycle battery locally. For safety it is important to sand the propellers to round the sharp edges before using them. The two people operating the engine must wear soft leather gloves and safety glasses. A plastic bottle used to dispense solvent for acrylics makes a great primer bottle for the .049 engine. Five rechargable 'D' batteries hooked in parallel can be used for operating the glow plug.

APPENDIX: FUEL COST COMPARISON

Fuel	BTU Value
Propane	91,500 BTU's/Gallon
Nat. Gas	1,000,000 BTU's/MCF
Fuel Oil	140,000 BTU's/Gallon
Electric	3,413 BTU's/KW
Coal	29,200,000 BTU's/Ton
Wood	27,472,500 BTU's/Cord



*(Seasonal Performance Factor)

(All figures shown in dollars per unit)

Directions: Select a price for any fuel, then draw a horizontal line across the page to find the equivalent cost of any other fuel.

Example: Using a geothermal heat extractor @.05¢ per KW, you would have to be able to purchase fuel oil at 25¢ per gallon to be cost competitive.

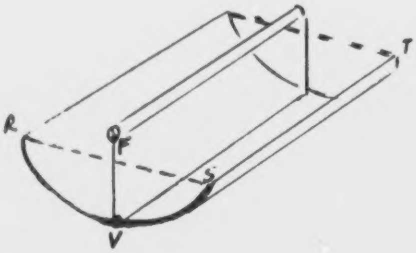
APPENDIX: ENERGY RESOURCE BANK WORKSHEET

	CHEMICAL	HEAT	MECHANICAL	SOUND	ELECTRICAL	LIGHT
CHEMICAL						
HEAT						
MECHANICAL						
SOUND						
ELECTRICAL						
LIGHT						

APPENDIX: ADDITIONAL MATH AND SOCIAL SCIENCE CONCEPTS

Math

A solar powered irrigation system uses trough shaped parabolic cylinders which track the sun's movement to collect solar energy. The focus of each parabolic cylinder is a tube of water, which is heated to provide input energy for turbine engines that power irrigation pumps.



Source: Yunker, Vannatta, and Crossivite. *Advanced Mathematical Concepts.* Merrill Publishing Co., 1981.

Social Science

The production of energy in the United States has often been surrounded by controversy. The construction of dams, and the subsequent flooding of surrounding lands, in order to produce hydro-electric power has frequently led to disagreements. Farmers have protested the loss of farm land; groups such as the Native Americans have complained about the desecration of sacred grounds; and conservationists have gone to court to protect endangered wildlife. The mining of coal has also generated intense debates and bitterness over the years. Strip mining, which laid bare the ground in order to uncover coal deposits near the Earth's surface, left the land scarred. In 1977 the Federal government passed legislation placing strip mining under Federal control. This law requires miners to restore stripped land to close to its original condition.

As we move toward the use of new resources to create energy, they come with their own set of problems. Probably the best example is the controversy over the use of nuclear power. The dangers to the surrounding environment in case of an accident (Three Mile Island, Chernobyl) are highlighted by anti-nuclear activists and environmentalists. In addition, the question of how to dispose of nuclear wastes has not been satisfactorily answered. The dilemma as to how to produce low-cost, abundant energy without damaging the environment will continue to be the focus of study and discussion in the near future.

INTRODUCTION TO TECHNOLOGY
TECHNOLOGY LEARNING ACTIVITY

SENSORS AND CONTROLS - THE ULTIMATE SYSTEM

MODULE NUMBER: T-8
NUMBER OF DAYS: 24

MAJOR CONCEPTS TO BE ADDRESSED

T-8A Some open-loop systems are programmed to achieve desired outcomes but are unable to adjust to changing conditions.

T-8B Sensors can be used to provide feedback about the presence or absence of a desired condition.

T-8C Closed-loop systems use feedback to overcome the inability of an open-loop system to adjust to changing conditions.

T-8D Closed-loop systems are designed to automatically adjust the control signal which modifies the process component. Thus, desired outcomes (within limits) can be achieved even if conditions change.

T-8E A technological system is controlled by: (a) sensing the output of the system, (b) comparing the sensed output with the command input, (c) making adjustments to control the process to better match actual output to the command input.

T-8F Computer systems can be assembled, programmed, and operated to perform open-loop and/or closed-loop tasks.

OVERVIEW OF TLA

Through the use of this TLA and Module T-8, the student will learn how technology is controlled. Monitoring will be studied through the use of open-loop and closed-loop systems. Students will assemble and operate systems using sensors (moisture, touch, light, movement, magnetism, and temperature). Using formalized problem solving, the students will adjust feedback to optimize the systems. Computers will be used to control one of the systems.

EQUIPMENT AND SUPPLIES

- Electronic modular kits (e.g., Feedback, Inc. PZ-10; Radio Shack project kits; Electronic Kits, Inc.; Graymark Electronics)
- Computer hardware
- Electronic sensors
- Readily available materials (wood, plastic, metals, etc.)
- Components necessary to complete students systems (fans, motors, pumps, light, timers, etc.)
- Hand and power tools
- Science Tool Kit software
- Other supporting software

PROCEDURE FOR THIS ACTIVITY

Days	POs*	Teacher Activity	POs*	Student Activity
1		Display a collection of common technological devices (e.g., sump pump, toaster, light control, cam for engine, motor speed control, burglar alarm, optical sensor - camera, thermostat). Show how an understanding of the operation and control of these devices will lead to wise use. This knowledge can be transferred to other systems. Pick examples of systems studied in Module T-4. Lead discussion and facilitate completion of systems diagrams.	la-c	Draw block diagrams to show the ability to differentiate between open- and closed-loop systems. Label system diagrams. Do Vocabulary Worksheet (see Appendix).
1	PO1	Facilitate discussion of above devices or examples of systems. Explain Appendix: Location and Use of Sensors.	PO1	Organize displayed systems into open-loop and closed-loop categories. Diagram examples in each aspect of technology. Complete Location and Use of Sensors.
1	2b 2c	Discuss limitations of human senses. Demonstrate how technological sensors monitor output. Demonstrate PZ-10, Radio Shack, or EKI sensors (moisture, touch, light, sound).	2a-c	List human senses and limitations and technological sensors in notebook. Complete systems diagrams for several displayed systems.
		Facilitate safe work in the lab. Explain Appendix: Human Sensors Worksheet.	2d PO2	Use human and technological sensors safely in systems already assembled. Complete Human Sensors Worksheet.
1	3a-c	Lead a discussion on feedback comparison made by humans, electronic and mechanical controls. Lead a discussion on how human, electronic, and mechanical feedback comparisons are made. Identify bang-bang and proportional controllers. Explain Appendix: Sensing and Control Charts.	3a 3b 3c	Complete system diagrams showing use of humans as comparators in the feedback loop. Complete systems diagrams showing use of electronic and mechanical controls. Label bang-bang and proportional controls. Complete Sensing and Control Charts.
10		Introduce problem: Given plans of a system from each of the aspects of technology, the students will assemble and operate a closed-loop system. See Appendix: Sample Design Brief for Controlling Artificial Environments.	PO3	Design and construct a controlled artificial environment. Follow procedures outlined in Sample Design Brief. Choose a sensor to sense outputs - sound, light, relay to fan, motor, pump. Use formalized problem solving for planning and construction of systems and sensors to optimize the solution. Operate the closed-loop system and draw the system diagram. Homework: Crossword Puzzle (see Appendix).
3		Introduce computer programs that cover control of systems (e.g., Robot Odyssey, Rocky's Boots).	4b	Operate the computer and program correctly.

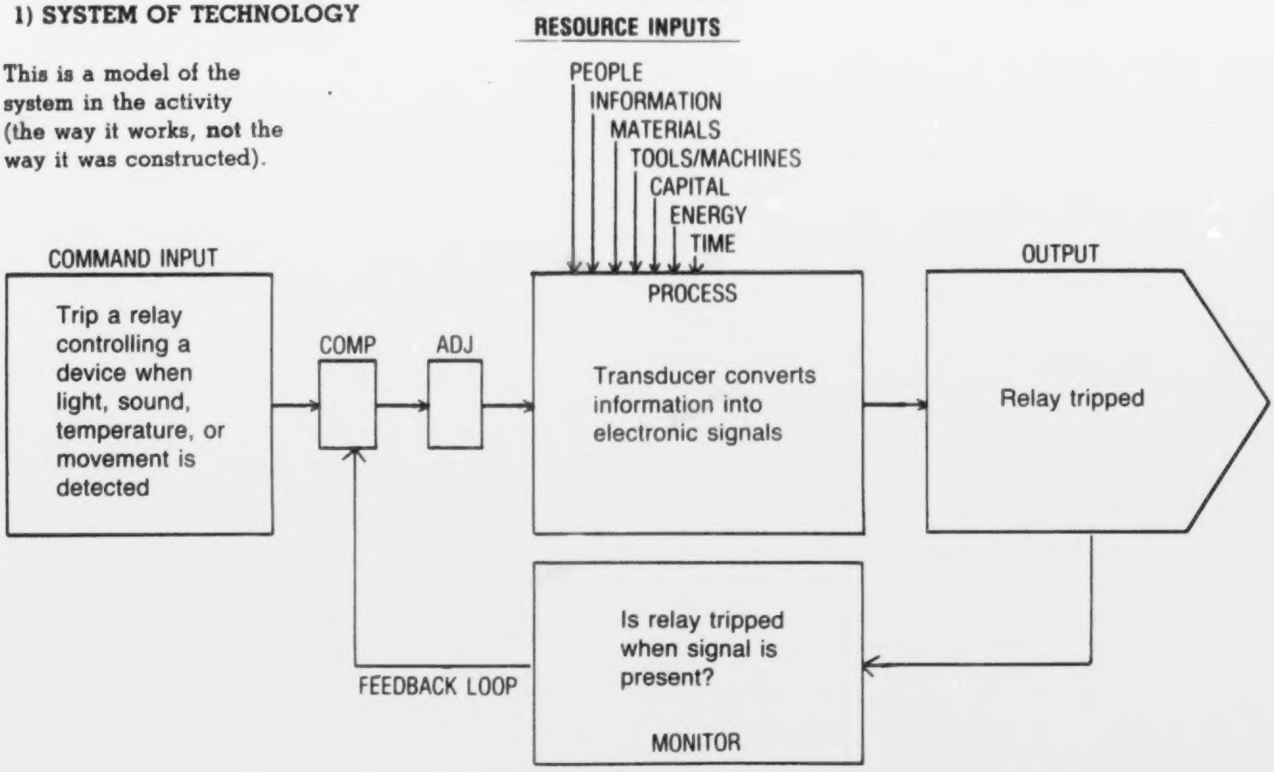
Days	POs*	Teacher Activity	POs*	Student Activity
1	4a 4b	Introduce computer control on systems such as appliance control, home receptacle control, or robotic arm. Demonstrate computer program and feedback control. Use printer, Kelp Interface Card, Robotic Kit, or other system (LEGO, etc.)	4a	Identify the parts necessary for a computer controlled technological system. (Assemble parts if possible.)
5		Monitor use of computer control systems.	P04	Use computer control device and software.
1		Evaluate student achievement. See Appendix: Sample Written Test.		Take test.
24 Total Days				

*See Syllabus for phrasing of performance objectives and supporting competencies.

CONSTANTS FOR INFUSION INTO THE TLA

1) SYSTEM OF TECHNOLOGY

This is a model of the system in the activity (the way it works, not the way it was constructed).


RESOURCE INPUTS
PEOPLE
INFORMATION
MATERIALS
TOOLS/MACHINES
CAPITAL
ENERGY
TIME
COMMAND INPUT
Trip a relay controlling a device when light, sound, temperature, or movement is detected
COMP
ADJ
PROCESS
Transducer converts information into electronic signals
OUTPUT
Relay tripped
Is relay tripped when signal is present?
MONITOR
FEEDBACK LOOP

IDENTIFY THE ROLE OF THE FOLLOWING RESOURCES IN THE SYSTEM ABOVE:
PEOPLE, INFORMATION, MATERIALS, TOOLS & MACHINES, CAPITAL, ENERGY, TIME.

2) **MATH** - Calculate volumes of rectangular prisms ($v = lwh$) and cylindrical shapes ($v = \pi r^2 h$). Use linear and area measurement in construction. Calculate amounts and cost of materials. Program a sequence of events to control environment by use of sensors. Read scales and meters.

3) **SCIENCE** - Human sensing, electrical meters, light, heat, energy, motion, sound, magnetism, moisture conductivity, voltage, pressure, electricity, DC motors, switches, resistance, signals, symbols, interpreting information (data), use of units describing air flow, temperature, humidity, etc.

4) **HUMAN & SOCIAL IMPACTS** - Automatic control leading to job change and/or elimination, extended life span, life support systems; aids in reduction of crime, property loss, smoke/fire damage, and water damage.

5) **COMMUNICATION SKILLS** - Sketching, drawing, planning, systems diagram, vocabulary enhancement, teamwork skills, electrical symbols, schematic representations, modeling, reading data.

6) **SAFETY AND HEALTH** - Sensing the favorable human environment, safe use of electricity, personal health and safety, sensing environmental hazards, safe use of hand and power tools/machines.

7) **PSYCHOMOTOR SKILLS** - Hand/eye coordination, manual dexterity.

8) **CAREER RELATED** - Electrical engineer, security and detection, computers and programming, environmental systems engineer, medical technicians.

9) **CREATIVE PROBLEM SOLVING** - Opportunities for creative problem solving will be provided by this TLA including: identification and definition of a problem, goal and criteria setting, generation of alternative solutions and recognition of limitations, optimization, testing and evaluation.

10) **TRANSFER OF LEARNING** - Relationship of student constructed system and sensors to immediate environment (home, school, etc.).

BACKGROUND REFERENCES AND RESOURCES

Barithwaite, Clive and Paul Fay. *Modular Courses in Technology: Electronics Teachers Guide*. Edinburgh, England: Oliver & Boyd, 1980.

Fay, Paul and Roy Pickup. *Modular Courses in Technology: Electronics*. Edinburgh, England: Oliver & Boyd, 1983.

Feedback, Inc., *Circuit - Modules Manual for PZ-10*. 620 Springfield Ave., Berkeley Heights, NJ 07922

Fischertechnik, Robotic Computing Kit. Fischer America, Inc., 175 Route 46 West, Fairfield, NJ 07006

Gannon, Michael. *Workbench Guide for Semiconductor Circuits and Projects*. Englewood Cliffs, NJ: Prentice-Hall, 1982.

Hacker, Michael and Robert Barden. *Technology In Your World*. Albany, NY: Delmar Publishers, 1987.

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Hall, Jeffrey and John Hucker. *Modular Courses in Technology: Instrumentation Teachers Guide*. Edinburgh, England: Oliver & Boyd, 1983.

Hall, Jeffrey and John Hucker. *Modular Courses in Technology: Instrumentation Workbook*. Edinburgh, England: Oliver & Boyd, 1983.

Kelp Interface Card. Crabapple Systems, Inc., 118 Commercial St., Portland, ME 04101

Mims, Forrest. *Engineer's Mini - Notebook*. Fort Worth, Texas: Tandy, 1984.

Mims, Forrest. *Getting Started in Electronics*. Fort Worth, Texas: Tandy, 1983.

Robotix R2000 Kit, Milton Bradley Co., Springfield, MA 01101

Science Tool Kit. Broderbund Software, 17 Paul Dr., San Rafael, CA 94903-2101

Todd, Ron., D. McCrory and K. Todd. *Understanding and Using Technology*. Worcester, MA: Davis, 1985.

EVALUATION

The teacher should develop a two component evaluation system to determine if the student understands: (1) performance objectives and (2) skills, attitudes, knowledge & safety related to the specific lab activity.

(1) EVALUATION OF PERFORMANCE OBJECTIVES (Examples)

1. Explain the difference between an open-loop system and a closed-loop system. PO1
2. Give examples of human and technological sensors being used to monitor the output of processes. 2a,b,c
3. List and explain the elements necessary to operate a closed-loop system. PO1
4. What is the advantage or disadvantage of using a computer to control a technological system? 3c

(2) EVALUATION OF SKILLS, ATTITUDES, KNOWLEDGE & SAFETY (Examples)

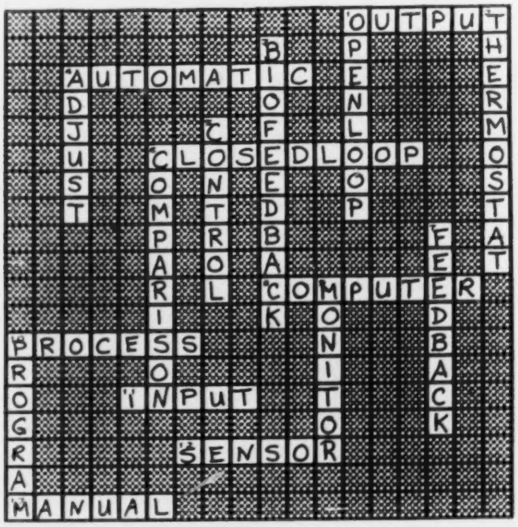
1. Show the symbol used in a schematic to indicate the location of the following components: a. resistor b. capacitor c. LED d. switch
2. What are the two most important things necessary for a good solder joint?
3. What are two methods used to lay out circuits on printed circuit boards?
4. A component is said to have polarity. What does that mean?

APPENDIX: VOCABULARY WORKSHEET

Define the following terms:

actual results
adjust
adjustment
automatic
automatic control
biofeedback
closed-loop system
compare
comparison
comparison device
computer
control
desired results
feedback
input
manual control
monitor
monitoring
open-loop system
output
process
program
program control
sensor
system
system theory
technological system
thermostat

Crossword Puzzle Answer Key



APPENDIX: LOCATION AND USES OF SENSORS

These are examples of where and how sensors are used. In the blank spaces below the double line, indicate what kinds of sensor could be used for the items listed.

PLACE/ITEM	SENSORS
Room	Temperature, light, ventilation, smoke, noise, security, humidity
Aquarium	Temperature, light, pumping, filtering, oxygen
Greenhouse	Temperature, light, soil Ph, soil moisture, humidity, watering system, nutrients
Factory	Temperature, light, transportation of materials and products, inventory, quality control
Milkbarn	Temperature, milk flow, humidity, ventilation, feeding systems, waste system
Poultry (egg) farm	Production, light, temperature, humidity, feed, ventilation, waste system
Small animal environment	Temperature, exercise, feed, waste removal, water
Security systems	Movement, sound, light, entry
Robot	
Train	
Boat	
Rocket	
Telephone booth	
Radio/television station	
Airplane	

APPENDIX: HUMAN SENSORS WORKSHEET

Choose two activities which you might do and identify the human senses that you use to do these activities. Indicate how the senses help you do the activity. Describe a device that might be used in place of the human sensing. Innovative devices are encouraged.

ACTIVITY: ____________________

HUMAN SENSOR(S)	HOW IT HELPS	REPLACEMENT DEVICE

ACTIVITY: ____________________

HUMAN SENSOR(S)	HOW IT HELPS	REPLACEMENT DEVICE

Name ____________________

Period ____________ Date ____________

APPENDIX: SENSING AND CONTROL CHARTS

Identify a system controlled by each of the technological sensors given below. List the system input (desired result), processes, and outputs. Give two possible uses for the system. Indicate what human senses could substitute for the technological sensor.

TYPE OF TECHNOLOGICAL SENSOR	SYSTEM NAME	INPUT	PROCESS	OUTPUT	HUMAN SENSE	TWO POSSIBLE USES
MOISTURE						
TOUCH						
LIGHT						
SOUND						
MAGNETISM						
TEMPERATURE						

Three methods of control are listed below. Indicate whether the type of control is open or closed loop. List the system name, input, process, output, and two uses for the system.

CONTROLLERS	TYPE OF CONTROL	NAME OF SYSTEM	INPUT	PROCESS	OUTPUT	TWO POSSIBLE USES FOR THE SYSTEM
TIMER						
RELAYS						
RADIO						

APPENDIX: SAMPLE DESIGN BRIEF FOR CONTROLLING ARTIFICIAL ENVIRONMENTS

After brainstorming a list of artificial environments that can be controlled, choose one and design and construct a working model of that system.

Your project must include:

1. Sketch and plan for your system.
2. Completed systems diagram handout sheet(s).
3. The design and utilization of at least one sensor (mechanical and/or electronic).
4. The use of one mechanical or electronic control device.
5. A short presentation, demonstration, and explanation of the operation of your model system.

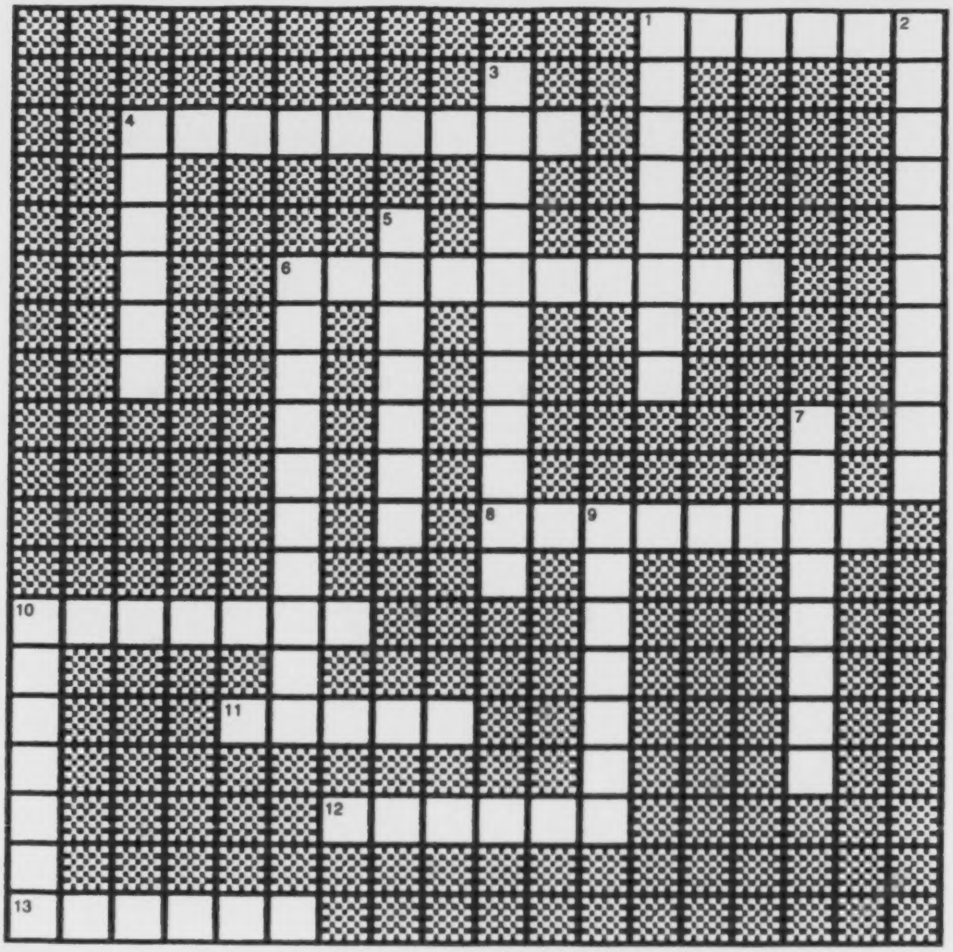
Examples of environments that might be modeled and controlled:

Space station
South Pole
Subterranean (underground)
Incubator
Hospital
Desert
Fish farm
Mushroom farm
Alantis (under sea)
Severe environment
Sterile environment

APPENDIX: SENSORS AND CONTROL CROSSWORD PUZZLE

NAME ____

DATE __________________ PERIOD ______________



ACROSS CLUES

1. The results of a system.
4. Type of system that controls itself.
6. Type of system that uses feedback control.
8. A tool used to control systems.
10. The part of a system where the job or work is done.
11. The desired results of a system.
12. A device that monitors the output of a system.
13. Human control of a system.

DOWN CLUES

1. Type of system that cannot be adjusted.
2. A sensor for heat.
3. Monitor of bodily functions for control.
4. To change the output of the system.
5. The process of adjusting a system.
6. A method of evaluation.
7. Information gained from the output to adjust and control the system.
9. To check output as with sensors.
10. A set of instructions to control a system.

APPENDIX: SAMPLE WRITTEN TEST

Answer each of the following questions in the space provided.

1. ____________ Which of the following is not considered to be a major aspect of technology?

A. biotechnology B. information/communication technology C. physical technology D. space technology

2. Place a "C" next to the below examples of closed-loop systems and an "O" for those systems considered to be open loop.

____________ Furnace thermostat

____________ Range top/surface burner

____________ Sump pump

____________ Attic fan

____________ Clothes dryer

3. Draw, label, and complete a systems diagram for a wind powered water pump.

4. Draw, label, and complete a systems diagram for an aquarium.

5. Draw, label, and complete a systems diagram for a frost-free refrigerator.

APPENDIX: SAMPLE WRITTEN TEST (Continued)

Match the human sense with the desired outcome and then identify a technological sensor that could be used in place of the human sense. Place the letter from the Desired Outcomes in the blank to the left of the Human Sense. Do the same for Technological Sensors. Letters may be used more than once in each category.

HUMAN SENSE

6. ______________ Sight
7. ______________ Hearing
8. ______________ Taste
9. ______________ Smell
10. ______________ Touch

DESIRED OUTCOMES

A. Volume of music
B. Salinity of soup
C. Filling a bath tub
D. Testing for a natural gas leak
E. Freshness of milk

TECHNOLOGICAL SENSORS

11. ______________ Moisture Sensor
12. ______________ Thermistor
13. ______________ Gas sniffer
14. ______________ Chemical lab analysis
15. ______________ Sound sensor, decibel meter

Explain how feedback is used to control the systems below:

16. Incubator ____

____

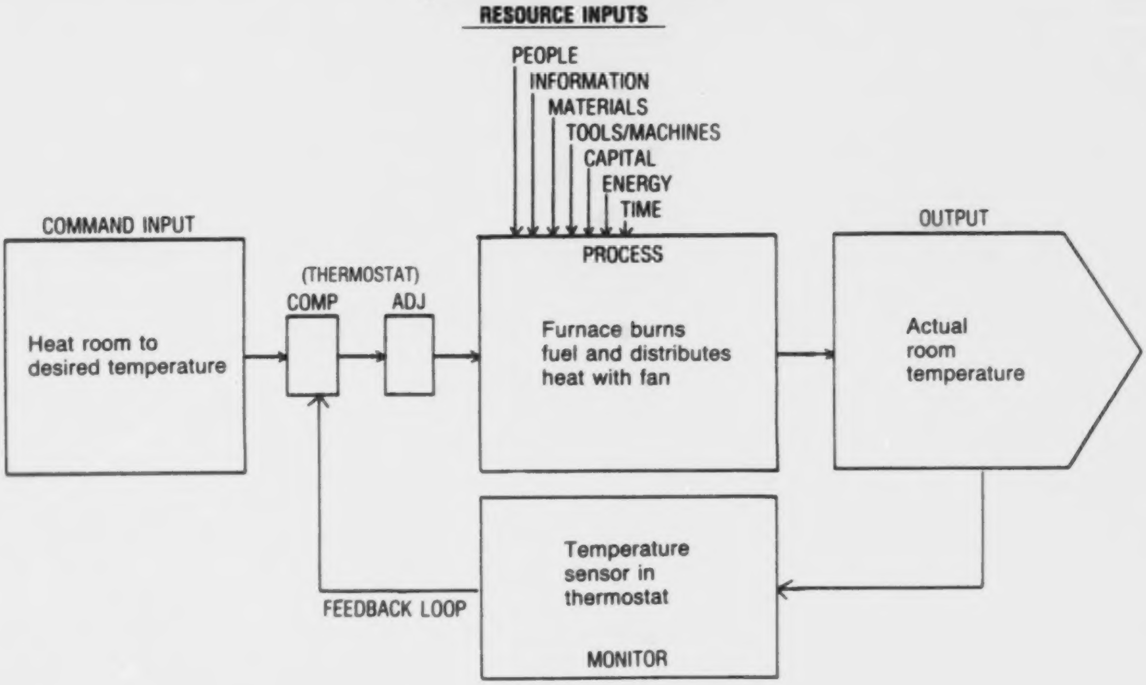
17. Greenhouse ____

____

APPENDIX: SAMPLE WRITTEN TEST (Continued)

Given the systems diagram below, describe how the components and system operate.

HOME HEATING SYSTEM


RESOURCE INPUTS
PEOPLE
INFORMATION
MATERIALS
TOOLS/MACHINES
CAPITAL
ENERGY
TIME
COMMAND INPUT
Heat room to desired temperature
(THERMOSTAT)
COMP
ADJ
PROCESS
Furnace burns fuel and distributes heat with fan
OUTPUT
Actual room temperature
Temperature sensor in thermostat
MONITOR
FEEDBACK LOOP

18. Resources

19. Input

20. Process

21. Output

22-25. Feedback Loop (includes monitor, comparator, and adjustor)

APPENDIX: ADDITIONAL SCIENCE AND SOCIAL SCIENCE CONCEPTS

Science

Living organisms are characterized by sensitivity. They respond to stimuli. Thus they are able to react to changes in the environment. For example if the light becomes dim, the pupils of our eyes adjust to allow more light to pass into the eye. These kinds of sensitivities help protect organisms from harm.

The nervous system of human beings is important in regulating body activities. The nervous system consists of the brain, sense organs, and nerve cells. The spinal cord, which with the brain makes up the central nervous system, is responsible for reflex action. Reflex action is automatic and protects the body. For example, if the sensory nerves pick up information that you are touching a hot pan, the receptor sends a message to arm muscles to contract, lifting the hand. A message also goes to the brain.

1. Motor nerves send messages from the brain and spinal cord to muscles.
2. Sensory nerves pick up messages from sense organs and send them to the spinal cord or brain.
3. Associative nerve cells connect sensory and motor nerves.

The sense organs pick up information from our environment and send the information to the brain where the information is acted upon. The senses include vision, hearing, taste, smell, and touch.

In designing ecosystems such as aquariums or terrariums, one must provide the conditions that living organisms require to survive in that habitat. Thus such factors as light, temperature, oxygen content, and moisture must be controlled.

An ecosystem is a distinct community of species and the nonliving environment with which the community interacts. For example a saltwater fish tank is an ecosystem in which the living organisms react with the nonliving environment and each other. Rocks and sand provide homes and anchorage for animals and plants. Cool water is the habitat of tiny protists which become the food of other organisms.

Ecosystems are affected by a variety of factors such as humidity (moisture in the air), temperature, and soil. For organisms to survive in an ecosystem they must have:

1. food
2. water
3. oxygen
4. proper temperature. All organisms have a temperature range beyond which they have difficulty surviving.
5. proper environment (includes living and nonliving things)

Social Science

People have used a variety of methods to protect their physical well-being and personal property. In pioneer days, people carried guns for defense and protection and neighbors joined forces to keep the peace. At times of disasters such as floods or fires, by the time the alarm was sounded, the danger was usually too far advanced, and total destruction was the likely outcome.

As the population in the United States increased and urban centers expanded, other means were employed to protect people and their belongings. Organized police forces were established and directed to maintain "law and order." Fire departments and emergency crews also came into being. These agencies not only handled problems as they occurred but attempted to prevent them from happening as well.

In today's society we still have police and fire departments but they are now assisted by technological systems. Instead of a night security guard, carefully placed monitored sensoring devices alert law enforcement officials of intruders in buildings. Heat sensing mechanisms draw attention to small fires, which can then be brought under control before they turn into major conflagrations. Advances in monitoring systems enable police and other officials to respond to potential trouble much more rapidly and effectively.

APPENDIX: ADDITIONAL SCIENCE AND SOCIAL SCIENCE CONCEPTS (Continued)

In addition to using sensors to provide information about external events, people also use sensors to control entire environments. The ability to develop and control an artificial environment is a phenomenon of recent origin whose effect upon our society is only now beginning to be realized. The potential impact of our ability to control our environment is expected to be felt significantly as we move into outer space and explore the ocean depths.

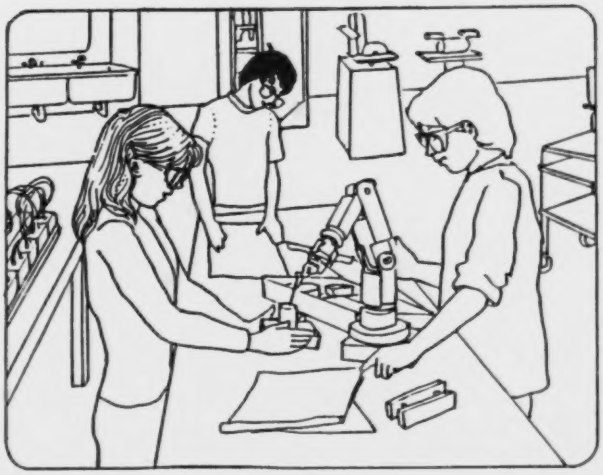
Ever since the launching of Sputnik by the Soviet Union in 1957, outer space has become a new frontier to be explored and conquered. The numerous satellites that have been placed in orbit over the intervening years have led to the establishment of space stations where astronauts have lived for brief periods of time. Increasingly larger and more complex space stations will enable modern explorers to stay in space for longer periods, engaging in scientific experimentation and leading the way for possible settlements.

Artificial environments are also making it possible to expand exploration of the seas. Already, underwater hotels are operative and plans are being made for expanding our food supply through underwater farming.

There is little doubt that over the next decades, outer space and the ocean floor will be centers of increased activity as improved systems are developed for surviving and working in these seemingly hostile regions of the universe.

INTRODUCTION TO TECHNOLOGY TECHNOLOGY LEARNING ACTIVITY

CONTROLLING TECHNOLOGICAL SYSTEMS



MODULE NUMBER: T-8
NUMBER OF DAYS: 20-30

MAJOR CONCEPTS TO BE ADDRESSED

T-8A Some open-loop systems are programmed to achieve desired outcomes but are unable to adjust to changing conditions.

T-8B Sensors can be used to provide feedback about the presence or absence of a desired condition.

T-8C Closed-loop systems use feedback to overcome the inability of an open-loop system to adjust to changing conditions.

T-8D Closed-loop systems are designed to automatically adjust the control signal which modifies the process component. Thus, desired outcomes (within limits) can be achieved even if conditions change.

T-8E A technological system is controlled by: (a) sensing the output of the system, (b) comparing the sensed output with the command input, (c) making adjustments to control the process to better match actual output to the command input.

T-8F Computer systems can be assembled, programmed, and operated to perform open-loop and/or closed-loop tasks.

OVERVIEW OF TLA

This TLA is designed to provide students with an understanding of how technological systems are controlled. Students will learn that systems can be controlled by feedback in closed-loop systems or by subsystems. In studying technological systems, students will compare the operation of open-loop and closed-loop systems. To accomplish the above the students will engage in various activities which may include but are not limited to the construction of a tantalizer game and/or the construction and operation of a mechanical, electrical, hydraulic, or pneumatic device.

EQUIPMENT AND SUPPLIES

- Robotic Arms (e.g., Armatron)
- Laboratory tools and machines
- Wood, sheet metal, plastic
- Hydraulic and/or pneumatic devices
- Glass mirror
- Various kits such as:
  Feedback, Inc. PZ-10 Control Technology modules
  Festo Didactic Pneumatic & Hydraulic models
  LEGO® Technic Pneumatic Kit
- Shampoo bottles, balloons, aquarium tubing
- Kelp Interface Card and Disc

PROCEDURE FOR THIS ACTIVITY

Days	POs*	Teacher Activity	POs*	Student Activity
1	1a 1b 1c	Introduce concept of controlling technological systems. Review the universal systems model and explain the concepts of open- and closed-loop systems.	1a 1b 1c	Take notes and participate in discussion. Describe how various systems in the home are controlled. For homework, draw block diagrams of home systems which are open loop with program control and systems which are closed loop and explain the differences between open- and closed-loop systems.
1	PO1	Use Armatron or mobile Armatron to indicate which senses are used as a person controls the Armatron. Contrast human control with machine control by interfacing Apple Computer with Kelp Interface Card and Disc or show film, video, etc. which depicts how robots work in industry.	PO1	Perform various pick and place operations with Armatron. View a movie or use Kelp Interface Card to operate Armatron electronically. In performing this operation differentiate between human and technological sensors.
4	2a 2c	Discuss which human senses illustrate how humans can monitor the output of a technological system. Relate how technological sensors are used in a system. Give examples.	2a 2b 2c 2d PO2	Use human senses to determine various outputs from technological systems (e.g., determine if wood is smooth or rough, is toast burning, is room warm enough). Use tools, materials, and equipment safely in the lab to demonstrate how technological sensors operate. In completing this assignment demonstrate the use of human and technological sensors to monitor the output of a process.
1	3c	Explain how mechanical, electronic, hydraulic, and pneumatic controls are used. Demonstrate various kits and safe use of lab tools and equipment.		Take notes. Answer questions about types of controls and explain how several common systems are monitored and controlled by feedback.
7-17		Demonstrate safe use of tools and machines needed to construct closed-loop system. Assign various activities so that students will better understand technological controls. Activities include the construction of a tantalizer game (see Appendix), using a robotic arm, problem solving, and constructing a device that uses electronic, mechanical, hydraulic, and/or pneumatic principles. Examples: water tank float system, home heating system, photocell controller. Distribute Activity Sheet (see Appendix).	3a 3b 3c 3d PO3	Begin fabrication of closed-loop system or use kits which utilize technological sensors. During the course of the construction process, compare the actual results to the desired results, use subsystems as comparison devices, and explain how the system assembled is controlled by feedback through electronic, mechanical, hydraulic, and/or pneumatic devices. Using Activity Sheet as a model, analyze other common systems.

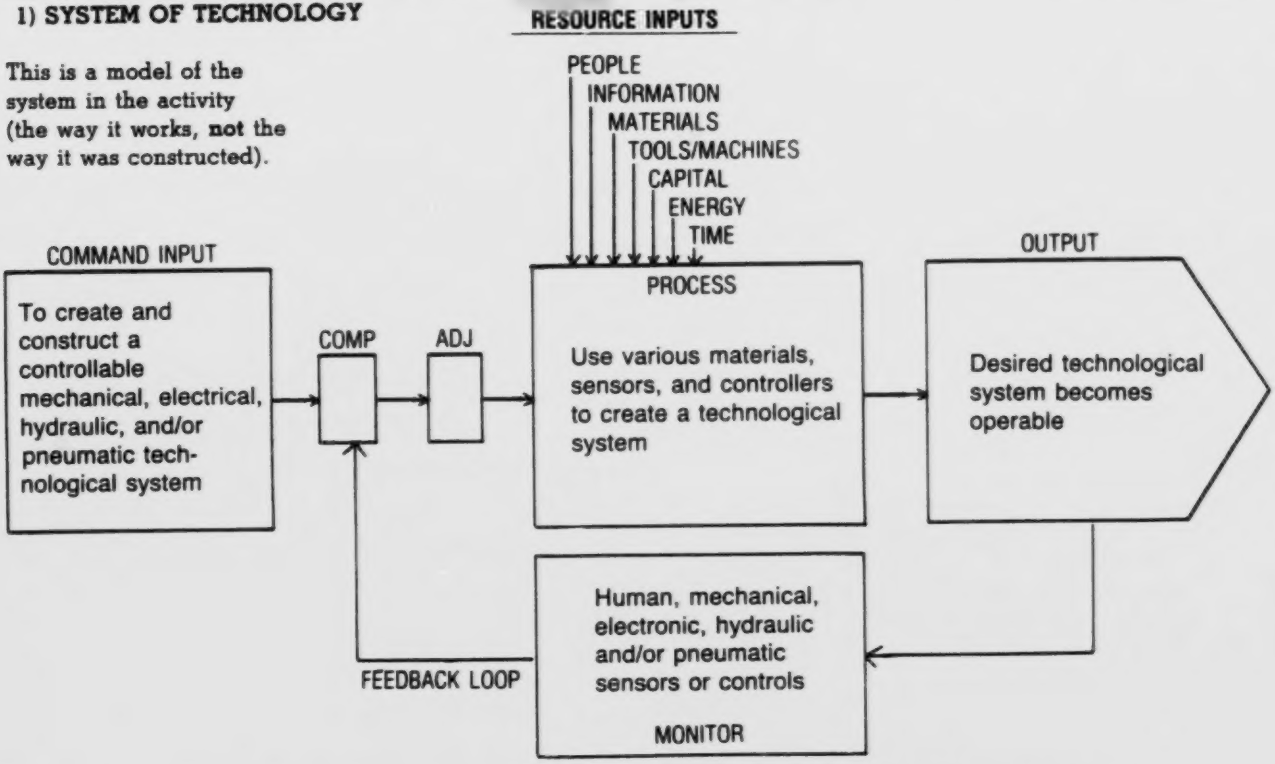
Time Days	POs*	Teacher Activity	POs*	Student Activity
5	4a 4b PO4	Introduce the computer and explain how the computer can be used as a tool to control technological systems. Demonstrate various devices that use a computer to control the system. Assign a problem where students will have to use a computer to control a technological system.	4a 4b PO4	Using various kits, devices, or materials from home or laboratory, assemble a computer controlled technological system. To operate the system, use the computer and appropriate software to allow the system to follow a sequence of steps or instructions.
1		Summarize and review activities. Administer a prepared examination.		Participate in review. Take examination.
20-30 Total Days				

*See Syllabus for phrasing of performance objectives and supporting competencies.

CONSTANTS FOR INFUSION INTO THE TLA

1) SYSTEM OF TECHNOLOGY

This is a model of the system in the activity (the way it works, not the way it was constructed).


RESOURCE INPUTS
PEOPLE
INFORMATION
MATERIALS
TOOLS/MACHINES
CAPITAL
ENERGY
TIME
COMMAND INPUT
To create and construct a controllable mechanical, electrical, hydraulic, and/or pneumatic technological system
COMP
ADJ
PROCESS
Use various materials, sensors, and controllers to create a technological system
OUTPUT
Desired technological system becomes operable
FEEDBACK LOOP
Human, mechanical, electronic, hydraulic and/or pneumatic sensors or controls
MONITOR

IDENTIFY THE ROLE OF THE FOLLOWING RESOURCES IN THE SYSTEM ABOVE: PEOPLE. INFORMATION. MATERIALS. TOOLS & MACHINES. CAPITAL. ENERGY. TIME.

2) MATH - Line Symmetry - mirror as the line of reflection (in tantalizer game). Programming a computer controlled technological system; sequencing operations that involve distance (motion) and degrees of turning (angles). Degrees of turning can be found by taking a fractional part of 360° or using ratio and proportion.

3) SCIENCE - The nervous system helps to regulate and coordinate body activities. Learning processes are related to our ability to perceive sensations: sight, smell, hearing, taste, and touch. These senses provide us with the external factors of an object. Conditioning is the changing or modification of behavior patterns due to an association between different kinds of stimuli. Electromagnetic energy is transferred by waves. There are different kinds of electromagnetic waves including infrared waves and light waves. When light rays strike a surface, some will be reflected, some will be absorbed, and some will pass through the object. Dark objects reflect less light and infrared radiation than light objects.

4) HUMAN & SOCIAL IMPACTS - Automatic control systems have affected methods of production and have led to new occupations, new patterns of living, and a changing work force. A discussion of these changes could lead into a projection of what the implications might be for the United States as a result of the increased use of robots in American and foreign industries.

5) COMMUNICATION SKILLS - Use of systems to illustrate methods of process control. Use of matrix charts.

6) SAFETY AND HEALTH - Role of automation in reducing workers' exposure to hazardous environments and materials.

7) PSYCHOMOTOR SKILLS - Manipulation of robot arm. Keyboard entry of commands.

8) CAREER RELATED - Systems engineers, automation technicians.

9) CREATIVE PROBLEM SOLVING - Opportunities for creative problem solving will be provided by this TLA including: identification and definition of a problem, goal and criteria setting, generation of alternative solutions and recognition of limitations, optimization, testing and evaluation.

10) TRANSFER OF LEARNING - Students are asked to explain the operation of various systems, given general concepts.

BACKGROUND REFERENCES AND RESOURCES

Videotapes:

"The New Industrial Revolution" (13 mins.) - Onondaga-Madison BOCES

Movies:

"The Robot Revolution" (18 mins.) - Onondaga-Madison BOCES
"Ballet Robotique" (10 mins.) - Oswego County BOCES

Filmstrips:

"Robot Nomenclature," "Robots in the Workplace," "Robot Classification," and "Basics of the Teachmover Robot"
Available from: Bergwall, P.O. Box 238, Garden City, NY 11530-0238

"Robotics: Science Fiction Come True" (F8507), "Introduction to Robots" (F8507A), and "Robots in Everyday Life" (F8507B)
Available from: Eye Gate Media, 3333 Elston Ave., Chicago IL 60618

Catalogs

Creative Learning Systems
San Diego, CA
(hardware/software catalog)

Radio Shack
Fort Worth, Texas 76102
(hardware/software catalog)

Heath Kit Electronic Center
3476 Sheridan Road
Amherst, NY 14226
(component catalog)

Books

Armborg Auto Initialization Manual. Berkley Heights, NJ: Feedback Inc., 1984.

Dorf, Richard C. *Robotics and Automated Manufacturing*. Reston, VA: Reston Publishing Company, 1983.

Hacker, Michael and Barden, Robert. *Technology in Your World.* Albany, NY: Delmar Publishers, 1987.

Osborne, David M. *Robots, An Introduction to Basic Concepts and Applications.* Detroit: Midwest Sci-Tech Publishers, 1983.

Todd, Ronald, McCrory, David, and Todd, Karen. *Understanding and Using Technology.* Worcester, MA: Davis Publications, 1985.

Ullrich, Robert A., "*The Robotics Primer.*" Englewood Cliffs, NJ: Prentice Hall, 1984.

Periodicals and Articles

Cornish, Edward S. (ed.). *The Futurist,* February 1983 issue.

DeGarmo, Scott. (ed.). *Science Digest,* April 1983 issue.

Peckham, Susanne. "Secondary Students Tackle Robotics," *School Shop,* November 1982, pp. 17-19.

Robotics Age, 174 Concord Street, Peterborough, NH 03458 (monthly magazine on robotics)

Unimation, Inc. *Robots in Industry.* Danbury, CT: Unimation, Inc.

Kits and Computer Software

Festo Didactic Hydraulic and Pneumatic models
Festo Corporation
395 Moreland Road
Hauppauge, NY 11788

Kelp Interface Card and Program Disc
Crabapple Systems, Inc.
80 Elm Street
Portland, ME 04101
Cost $124.95

LEGO® Technic Pneumatic Kit
available at toy stores

PZ 10 Control Technology
RJT Education Training Systems
561 Jerome Court
Franklin Square, NY 11010
Cost: $350.00

EVALUATION

The teacher should develop a two component evaluation system to determine if the student understands: (1) performance objectives and (2) skills, attitudes, knowledge & safety related to the specific lab activity.

(1) EVALUATION OF PERFORMANCE OBJECTIVES (Examples)

1. Draw a systems diagram which depicts how a plant is grown from seed. Describe the system and indicate if it is an open- or closed-loop system. PO1

2. After constructing a closed-loop technological system, describe to the class how that system works, especially the components of monitor and control. PO2

3. Have students use the computer to program a mobile Armatron so that it moves in a 20-inch square and returns to its original location. PO4

(2) EVALUATION OF SKILLS, ATTITUDES, KNOWLEDGE & SAFETY (Examples)

1. What items should be worn when operating power equipment in the lab?

2. Dust and moisture can be harmful to computer discs. T/F

APPENDIX: ACTIVITY SHEET

FEEDBACK SYSTEM	DESIRED OUTCOME	SENSING & MONITORING	COMPARISON	ADJUSTMENT
WATER TANK	Desired water level (set screw)	Float	Bar & Pivot	Closing a valve
HEATING	Temperature setting	◄ —— Thermostat ——► Bi-Metallic strip	Gap between points, or angle of mercury capsule	On-off switch
LINE TRACER	Black line	Infrared eyes	Microprocessor	On-off signal to appropriate wheels
SOUND	Change direction when sound is heard	Microphone	Microprocessor	On-off signal to change direction
ELECTRIC LIGHT CONTROL	Light on when dark	Photocell	Triac	Transistorized switch or relay
OTHER				

APPENDIX: LIQUID LEVEL CONTROL

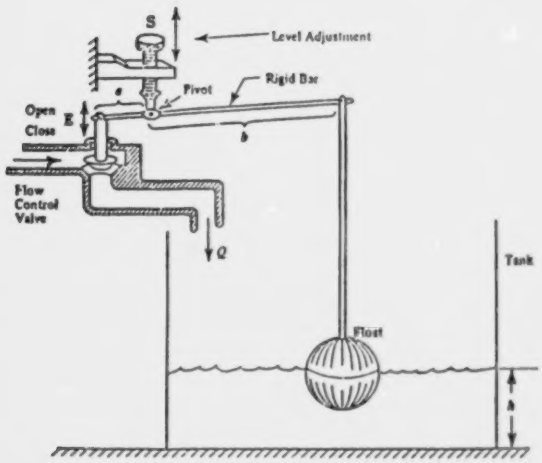

S
Level Adjustment
Rigid Bar
Pivot
a
Open
Close
E
b
Flow
Control
Valve
Q
Tank
Float
h

Figure 1. Liquid Level Control

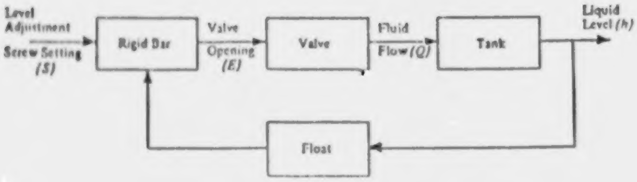
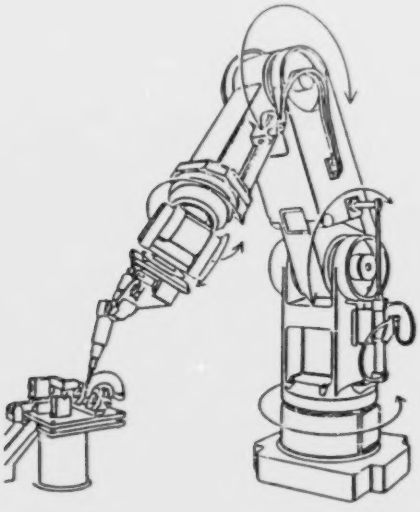

Level
Adjustment
Screw Setting
(S)
Rigid Bar
Valve
Opening
(E)
Valve
Fluid
Flow (Q)
Tank
Liquid
Level (h)
Float

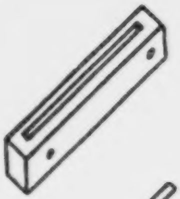
Figure 2. Block Diagram of Liquid Level Control

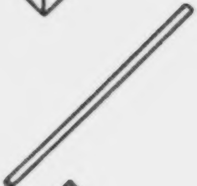
APPENDIX: ROBOTIC ARM

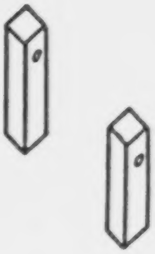


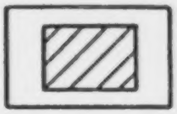
APPENDIX: DIRECTIONS FOR CONSTRUCTION OF TANTALIZER GAME

Part List

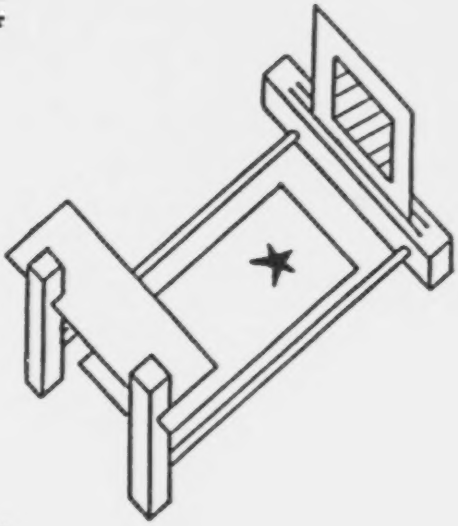
(1)  **Mirror Holder**

(2)  **Dowels**

(3)  **Shield Holder**

(4)  **Mirror**

(5) **Shield**



Assembled Tantalizer

Assembly (refer to drawing)

1. Put mirror (4) into mirror holder (1)
2. Connect dowels (2) into mirror holder (1)
3. Connect other end of dowels (2) to shield holder (3)
4. Put shield (5) into slots of shield holder (3)

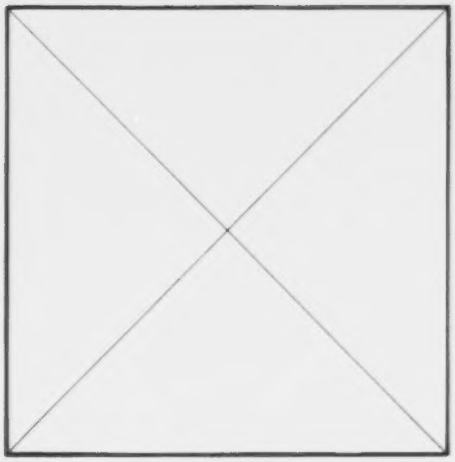
How to operate tantalizer

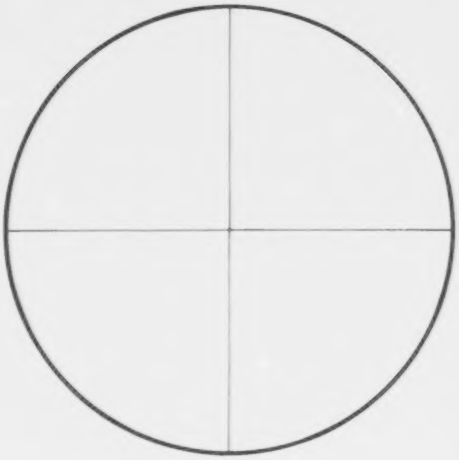
1. Place piece of paper with star under tantalizer (shown in drawing above). Place hand under shield, put pencil point on star.
2. Trace the star by looking at the image in the mirror.

This project was suggested by 8th grade Technology I pupils
in the technology laboratory at Royalton Hartland Central School.

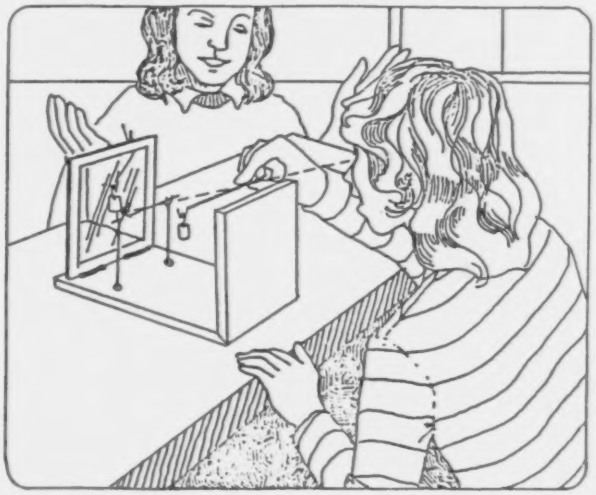
APPENDIX: DIRECTIONS FOR CONSTRUCTION OF TANTALIZER GAME (Continued)

Tracing sheets for the tantalizer game





Another version of the tantalizer game involves the use of feedback to position a tool to hook a hanging object. Any opaque material can be used for the vision screen. Any convenient material may be used to construct a positioning device for the mirror and vision screen.



APPENDIX: OTHER ACTIVITIES

1. Pneumatic devices can be constructed by students through the formal problem-solving approach. Give students an old shampoo bottle which has a small spout, small diameter aquarium tubing, and a balloon and have them construct a vehicle which incorporates a pneumatic control as part of the vehicle.

2. Have students solve a hydraulic control problem. Using glue injectors, aquarium tubing, and water, the students can construct a device which uses hydraulics to control a mechanism.

APPENDIX: ADDITIONAL SOCIAL SCIENCE CONCEPTS

Social Science

The Industrial Revolution brought about significant changes in the labor field by replacing hand tools with more complex machines. This led to the production of goods using less human labor. We have now reached the point where machines are doing routine work in offices and factories with minimal human input.

The "robot revolution" has led to a profound change in manufacturing techniques. In ever increasing instances we no longer have men and women performing repetitive tasks; machines handle these basic chores. A technician or two can control an entire assembly line with the "flick-of-a-switch." Simply by changing a packet of computer chips, a machine can be programmed to do different jobs.

The Japanese were the first to automate their factories, but American industry is moving rapidly in that direction as well. Robots are not only being used in the aircraft and automobile industries but also assembling windows, mining coal, and washing windows. Robots can do dirty, boring, and dangerous jobs and at far less cost than a worker's hourly wage.

It is predicted that by the early 1990s about one-half of the American work force will labor at "electronic work stations." Major retraining efforts are needed for employees being displaced by new technology.

INTRODUCTION TO TECHNOLOGY
TECHNOLOGY LEARNING ACTIVITY

FUTURE VISIONS: BECOMING PART OF THE SOLUTION

MODULE NUMBER: T-9
NUMBER OF DAYS: 15

MAJOR CONCEPTS TO BE ADDRESSED

T-9A Technological systems must be assessed on the basis of their impact on people, society, and the environment.

T-9B Technological evolution can be projected into the future world.

T-9C As emerging technologies replace existing technologies, new industries will develop.

T-9D Work, job opportunities, and careers are in constant change because of the evolution of technology.

T-9E The development of flexible attitudes and transferable skills will increase the adaptability of persons to the rapid evolution of technology.

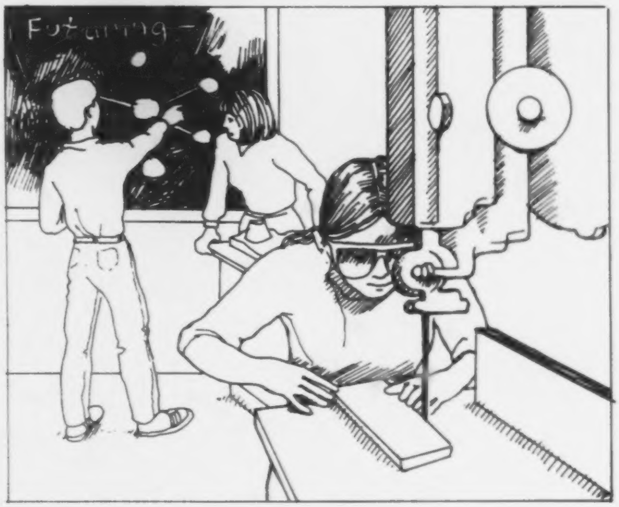
T-9F The development of leadership and social skills allows individuals to pursue technological careers with higher levels of responsibility.

T-9G Technology has an impact on personal, local, national, and international issues. These impacts, whether perceived or actual, may take many forms.

T-9H The rapid spread of technology has created world competition for jobs, resources, and markets.

T-9I Technology is making the world interdependent, resulting in the need for more international cooperation by sharing things such as resources, technical expertise, and markets.

T-9J Technological systems must be controlled for the continued well-being of the world.



OVERVIEW OF TLA

The impact of technological systems upon society and the environment can be positive or negative, predictable or unpredictable. The ability to predetermine outcomes using futuring techniques can be a powerful tool in selecting appropriate technologies for the future.

Technology has united the countries of the world into an interdependent network. It has also impacted upon the environment to create global pollution and disaster.

This two-part activity will first address futuring techniques and the impact of technology on jobs of the future. The second part of the activity will allow students to model alternative solutions to technological problems on a local, national, and global level.

Through letter writing, students will contact government and business leaders to voice their opinions on issues they chose to model, thus becoming part of the solution, not the problem.

EQUIPMENT AND SUPPLIES

- Tools and machines found in most general lab facilities
- Materials to prepare visual displays (video system, photographic equipment, computer hardware and software)

PROCEDURE FOR THIS ACTIVITY

Days	POs*	Teacher Activity	POs*	Student Activity
1	1a	Define the term futurist. Lead a class discussion on the role of people as futurists. Identify futurists and read parts of their work to students (Toffler, Naisbitt, Fuller).	1a	Participate in class discussion, sharing thoughts and experiences. Locate books written by futurists in library for personal reading. React verbally or in writing to predictions made by futurists.
	1b	Discuss techniques used by futurists to predict both positive and negative impacts on society and the environment. Demonstrate techniques such as the Future Wheel, Delphi Survey, Cross Impact Analysis, and Trend Analysis using technological systems generated through class discussion (see Appendices).	1b	Participate in class discussion and work through each futuring technique with teacher.
1	1c 1d	Identify emerging technologies in each of the three aspects of technology. Describe how technologies may have a socio-technological impact on local, national, and global levels.	1c 1d PO1	Construct a futuring instrument to predict possible consequences of these emerging technologies on local, national, and global levels.
1		To demonstrate the concept of socio-technological impact, focus on the changing job market as a result of new technology and global economics.		
		List products in the classroom and at home that are imported items;		Generate list of imported items.
	2a	discuss the imbalance in trade and why such an imbalance exists (include government owned industry, low wages, robotics, new industry vs. established industry, etc.).	2a	Brainstorm as to why foreign countries may have an edge over the U.S. in production of various products. Discuss loss of certain job categories in the U.S.
1	2a	Discuss local and national consequences of global competition. An impact that should emerge as a spoke in the students' future wheel should be the effect on jobs and careers in the future.	2a	Use future wheel technique to show possible future consequences of global competition on the local and national levels.
	2b 2c	Identify careers made obsolete by new technologies (over the last 100 years) and changes in society as a result.	2b 2c	List careers made obsolete over the last 100 years by emerging technologies.
1		Continue discussion by focusing on the impact of technology on jobs of the future. One strategy would be to invite a guest speaker. A local business leader or high school or college career counselor would be an excellent resource.	2c	Describe educational requirements for various occupations. For homework, collect information regarding careers in past, present, and emerging technologies.
1		Structure the format for a class database which includes information about past, present, and emerging technological careers.		Input information into career database. Use database to learn about additional careers.

FUTURE VISIONS: BECOMING PART OF THE SOLUTION

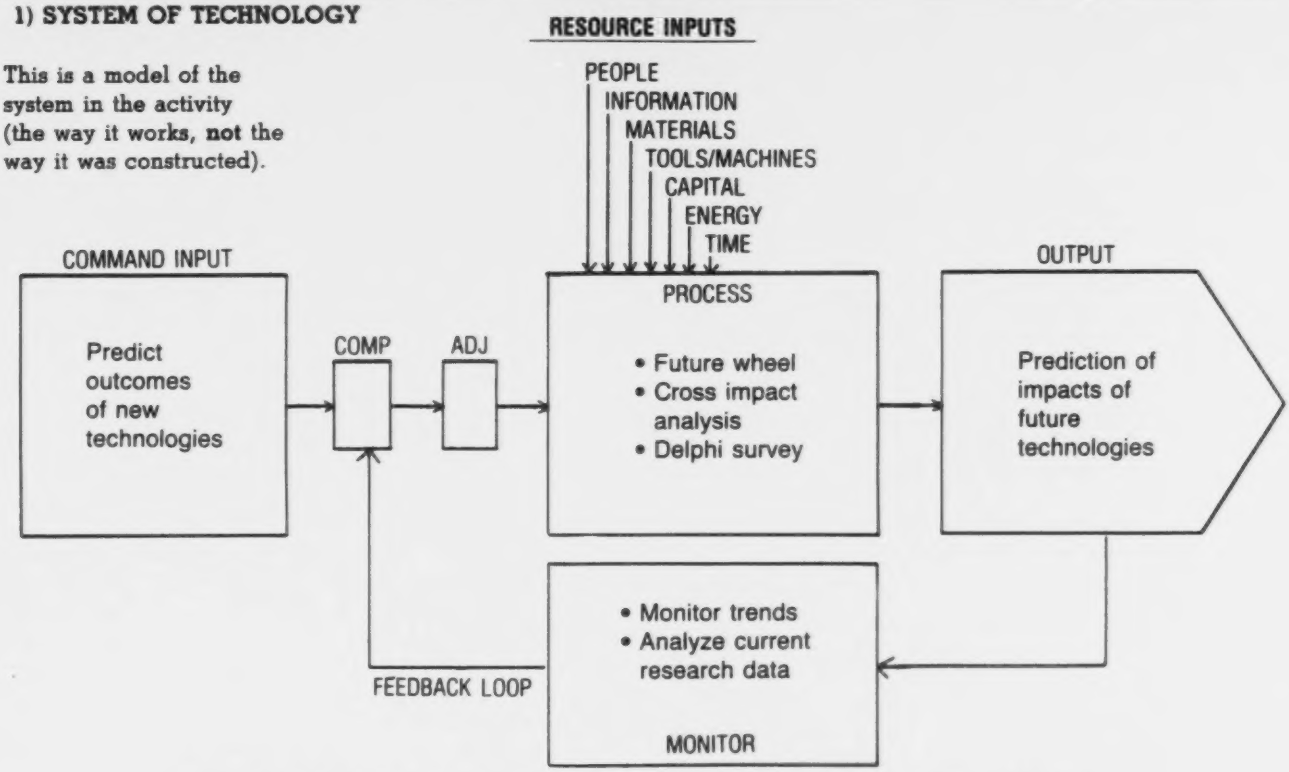
Days	POs*	Teacher Activity	POs*	Student Activity
	2d 2e 2f	Topics should include: • specific careers in emerging technologies • appropriate educational programs for future careers • skills and work attitudes • basic skills acquired that can be transferred to other employment	2d 2e 2f	Ask questions and participate in discussion.
1		Prepare criteria that will enable students to identify emerging careers as well as obsolete occupations. (Emerging careers - characterized by use of high tech, confluence of technological systems, information intensive. Obsolete careers - labor intensive, energy intensive.)	PO2	Demonstrate understanding of jobs created and made obsolete by technology through verbal interaction with teacher or through an examination.
	3a	List and categorize issues of local, national, and global significance. Discuss underlying causes of these issues.	3a	Share ideas and help with listing.
7		Assign the following activity: Select an example of a local, national, and global issue which is technology related. Using futuring techniques, predict positive and negative impacts. Select one negative impact from any issue and suggest alternative solutions to the technological problem.	3e 3f	Choose a global, national, or local issue from the list generated and begin work on a solution by making a model, prototype, graphic display, timeline, videotape, etc. At the conclusion of the activity, hand in: a graphic display of a futuring technique for the issue and suggested alternative using an acceptable modeling technique.
		Act as resource person throughout activity. Include instruction on safe use of tools and machines, material processing, etc.		
1		Lead discussion of ideas presented.		Present findings to the class.
		Provide addresses of corporate and government leaders and sample letter form. Proof letters.	PO3	For homework: write letters to appropriate people describing the activity, the findings, and the suggestions for alternative solutions.
15 Total Days				

*See Syllabus for phrasing of performance objectives and supporting competencies.

CONSTANTS FOR INFUSION INTO THE TLA

1) SYSTEM OF TECHNOLOGY

This is a model of the system in the activity (the way it works, **not** the way it was constructed).


RESOURCE INPUTS
PEOPLE
INFORMATION
MATERIALS
TOOLS/MACHINES
CAPITAL
ENERGY
TIME
COMMAND INPUT
Predict outcomes of new technologies
COMP
ADJ
PROCESS
• Future wheel
• Cross impact analysis
• Delphi survey
OUTPUT
Prediction of impacts of future technologies
• Monitor trends
• Analyze current research data
FEEDBACK LOOP
MONITOR

IDENTIFY THE ROLE OF THE FOLLOWING RESOURCES IN THE SYSTEM ABOVE:
PEOPLE, INFORMATION, MATERIALS, TOOLS & MACHINES, CAPITAL, ENERGY, TIME.

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2) MATH - Use decimals and percents to compare production costs (for specific items) in foreign countries and the U.S. Development of charts and graphs for presentation of data. Compass and straight edge constructions - concentric circles; perpendicular bisecting; copying line segments with dividers or rulers (for future wheels).

3) SCIENCE - Impact of emerging technologies on the environment and eco system. Investigation of new career opportunities in science and new areas of scientific study as a result of emerging technologies. Concept of time: past, present, future.

4) HUMAN & SOCIAL IMPACTS - New career market as a result of emerging technologies. Investigation of global interdependence and world market. Global impacts of technology. Changes in lifestyle.

5) COMMUNICATION SKILLS - Use of charts and graphics to convey an idea. Interacting with students and teacher to convey thoughts and feelings on a subject.

6) SAFETY AND HEALTH - Safe use of tools and machines. Health hazards as a result of technological impacts on the environment.

7) PSYCHOMOTOR SKILLS - Students will develop or improve eye-hand coordination through modeling techniques using various tools and materials.

8) CAREER RELATED - New careers as a result of emerging technologies. Skills that are transferable to new job situations. Career clusters; obsolete careers.

9) CREATIVE PROBLEM SOLVING - Opportunities for creative problem solving will be provided by this TLA including: identification and definition of a problem, goal and criteria setting, generation of alternative solutions and recognition of limitations, optimization, testing and evaluation.

10) TRANSFER OF LEARNING - Use futuring techniques to predict outcomes other than technology related.

BACKGROUND REFERENCES AND RESOURCES

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Space Frontier. L5 Society, Tucson, AZ 85719
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Toffler, Alvin. *Future Shock*. New York: Bantam Books Inc.

Toffler, Alvin. *The Third Wave*. New York: Bantam Books, 1980.

FILMSTRIP

Tomorrow is a Lovely Day. Film Strip Knowledge Unlimited, Inc. P.O. Box 52, Madison, WI 53701

EVALUATION

The teacher should develop a two component evaluation system to determine if the student understands: (1) performance objectives and (2) skills, attitudes, knowledge & safety related to the specific lab activity.

(1) EVALUATION OF PERFORMANCE OBJECTIVES (Examples)

1. Identify two methods used by futurists to predict future outcomes of technology. 1a

2. Use a futuring technique to anticipate possible future outcomes of a new technology (e.g., genetic engineering). PO1

3. Describe specific jobs created by computer technology; list jobs made obsolete by computer technology. 2b

4. What impact has robotics had on current job markets? PO2

5. For each of the three aspects of technology, give an example of a technological impact that has created a social issue. 3c

(2) EVALUATION OF SKILLS, ATTITUDES, KNOWLEDGE & SAFETY (Examples)

1. Based on your research, how can resources be used to better determine technological impacts?

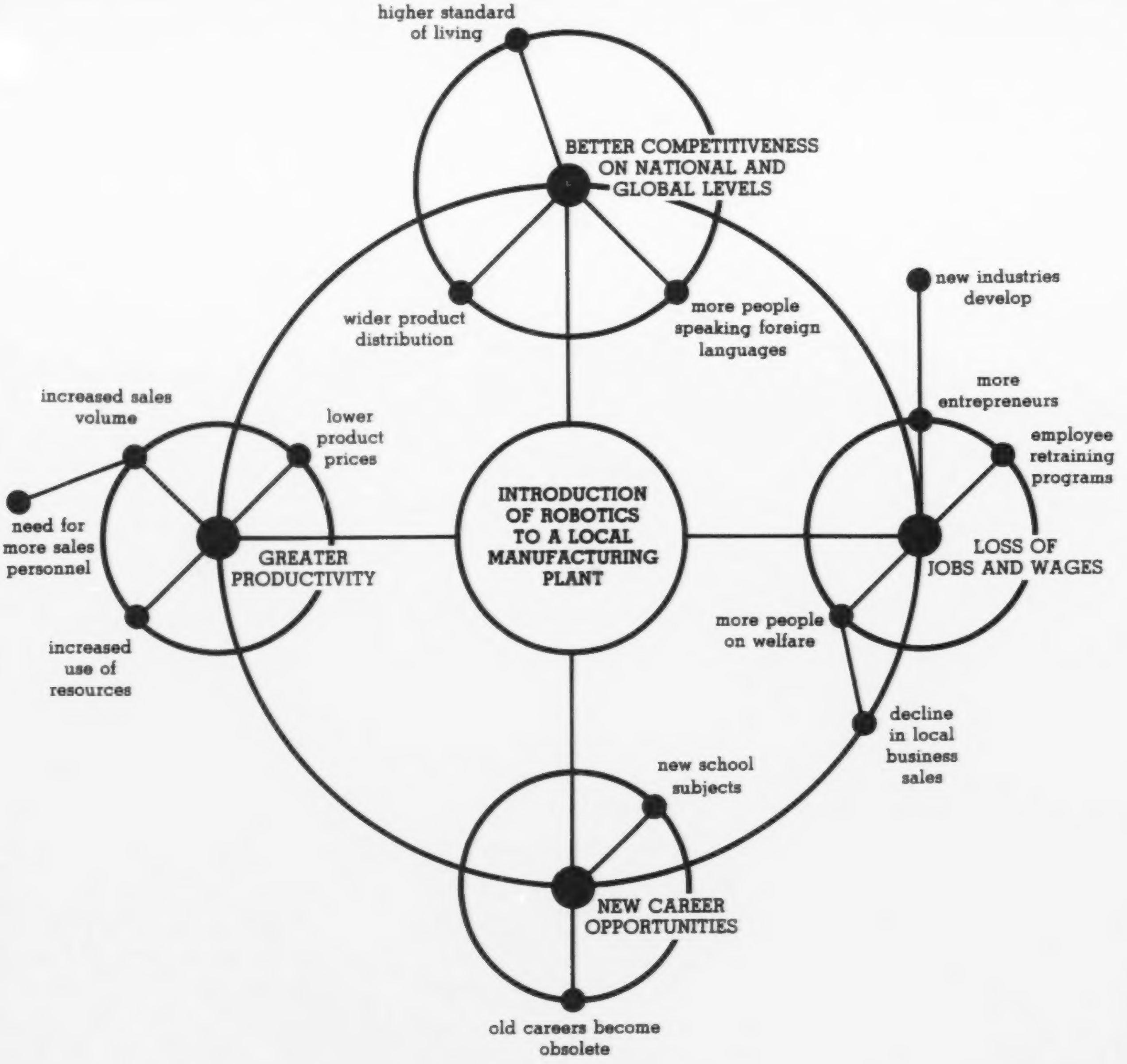
2. What are some essential skills and attitudes all employees should have?

3. What is Alvin Toffler most known for?

APPENDIX: SAMPLE CROSS IMPACT ANALYSIS

	FOREIGN COMPETITION	RISING EDUCATION COSTS	INDUSTRIAL RETRAINING PROGRAMS
DISPLACEMENT OF WORKER BY ROBOT	massive unemployment due to displacement and inability to compete in foreign markets; using robots to produce competitively priced products	not able to gain skills needed to retrain for new jobs in technological fields	employees acquire new skills as jobs become obsolete
LONGER LIFE SPAN	increased population leads to increased demand for foreign products	more older people will be displaced workers; early retirements	a person can change careers many times throughout one's life
DISCOVERY OF ALTERNATIVE RESOURCES	cheaper energy permits decrease in price of American goods allowing us to become more competitive with foreign countries	alternative methods of education provided using technology as a tool to provide it (e.g., television learning, video discs, computer-aided instruction)	corporations take over schools; industrial programs can be offered at less expense

APPENDIX: SAMPLE FUTURE WHEEL


higher standard of living
BETTER COMPETITIVENESS ON NATIONAL AND GLOBAL LEVELS
wider product distribution
more people speaking foreign languages
new industries develop
more entrepreneurs
employee retraining programs
increased sales volume
lower product prices
need for more sales personnel
INTRODUCTION OF ROBOTICS TO A LOCAL MANUFACTURING PLANT
GREATER PRODUCTIVITY
LOSS OF JOBS AND WAGES
increased use of resources
more people on welfare
decline in local business sales
new school subjects
NEW CAREER OPPORTUNITIES
old careers become obsolete

APPENDIX: ADDITIONAL SCIENCE, MATH, AND SOCIAL SCIENCE CONCEPTS

Science

Science and technology are human activities. Science is the process of solving problems to gain an understanding of the natural world. Technology is the process of using resources, discoveries, inventions, and scientific knowledge to develop new products and/or processes in order to meet the needs and/or wants of society.

Science, technology, and society are closely related. When one changes, the other two are affected. For example, the invention of the steam engine had a major impact on society. Factories no longer had to be near water; machines could do work done previously by humans; new transportation systems developed (railroad and steamboat). As a result of studying the effects of the steam engine, the scientific field of thermodynamics developed. Nuclear energy was first discovered as a result of scientific research. The times (World War II) led to rapid development of nuclear weapons.

Science and technology affect business and industry. For example, the invention of the refrigerator did away with ice cutters. The field of electronics has created new jobs.

Technology can have global effects. Satellites have increased worldwide communication. Fallout from Chernobyl has affected people and agriculture in many European countries.

There are advantages and disadvantages to use of technological products. Continuous evaluation of technological devices and processes is needed. Possible bad effects on present and future generations and the environment should be considered. Some technological devices or processes may need to be terminated if the disadvantages outweigh the advantages (such as the use of DDT) or modified (such as using unleaded gasoline to reduce lead air pollution from automobiles).

In making decisions about technology use, trade-offs have to be made, often between benefits and burdens for society and/or environment. For example, burning coal has the short-term effect of providing cheap electricity, but air pollution is the result. Control of air pollution can be expensive. Use of coal in the United States will reduce our dependence on foreign oil. What trade-offs should be made?

Some ideas come from

Block J of the NY Science Syllabus

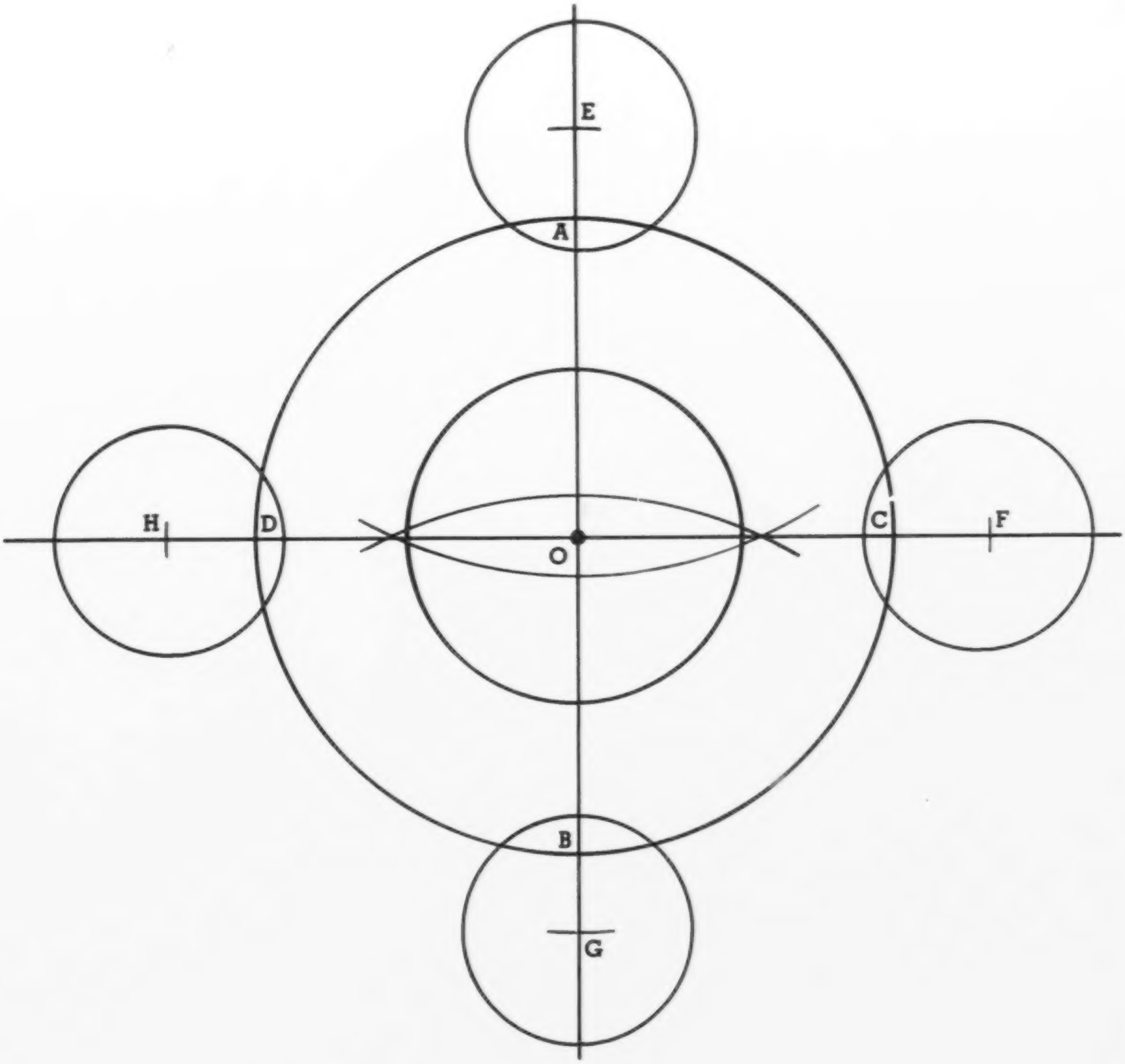
Koenig, Herbert, DeMarco-Keating, Mary Lou, and Lansing, Janet. *NYS-RCT Science Review*. Middletown, NY: N & N Publishing Company, 1987.

APPENDIX: ADDITIONAL SCIENCE, MATH, AND SOCIAL SCIENCE CONCEPTS (Continued)

Math

Sample future wheel showing basic construction:

1. Draw concentric circles with center O.
2. Draw diameter $\overline{AB}$ extended through A and B.
3. Draw $\perp$ bisector of $\overline{AB}$ to get line $\overline{CD}$.
4. Copy $\overline{OE}$ to get F, G, H (centers for smaller circles).



APPENDIX: ADDITIONAL SCIENCE, MATH, AND SOCIAL SCIENCE CONCEPTS (Continued)

Social Science

Throughout history, the labor force in the United States has responded to changing conditions in the society. The early settlers were basically farmers and primarily self-sufficient. They planted their crops, hunted the land, and made most of what they needed. As population and settlements increased, farming continued to be the major occupation but more small shops and businesses were established. The harness maker, grocer, and blacksmith started to provide goods and services to an increasingly complex society.

Then in the mid-1800s, the Industrial Revolution created a tremendous growth in industry. The small shops and businesses developed into major industries. Factories expanded and by the turn of the century, industrial goods exceeded agricultural production. With the subsequent growth of urbanization, many new jobs were created on the assembly lines and in the cities in order to meet the needs of a manufacturing economy.

Now, less than a century later, technological advances have placed new demands on the labor force. The number of industrial jobs in American factories is dwindling at a dramatic rate. With mechanized assembly lines taking the place of manual production, workers are being replaced and must now develop new skills. As we move into the "information age," jobs are increasingly requiring people to use computers and other technical equipment. Growth will also continue to be experienced in the service industries. Technological advances are creating new career fields which will require significant training and retraining.

INTRODUCTION TO TECHNOLOGY TECHNOLOGY LEARNING ACTIVITY

SURFACE SCIENCE TECHNOLOGY

MODULE NUMBER: T-9
NUMBER OF DAYS: 10

MAJOR CONCEPTS TO BE ADDRESSED

T-9A Technological systems must be assessed on the basis of their impact on people, society, and the environment.

T-9B Technological evolution can be projected into the future world.

T-9C As emerging technologies replace existing technologies, new industries will develop.

T-9D Work, job opportunities, and careers are in constant change because of the evolution of technology.

T-9E The development of flexible attitudes and transferable skills will increase the adaptability of persons to the rapid evolution of technology.

T-9F The development of leadership and social skills allows individuals to pursue technological careers with higher levels of responsibility.

T-9G Technology has an impact on personal, local, national, and international issues. These impacts, whether perceived or actual, may take many forms.

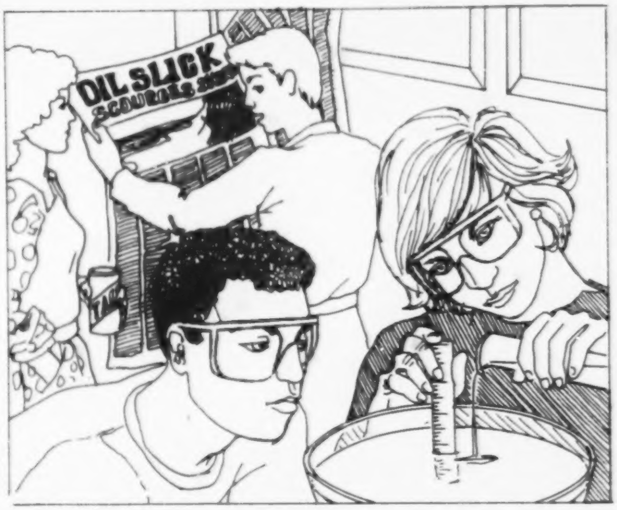
T-9H The rapid spread of technology has created world competition for jobs, resources, and markets.

T-9I Technology is making the world interdependent, resulting in the need for more international cooperation by sharing things such as resources, technical expertise, and markets.

T-9J Technological systems must be controlled for the continued well-being of the world.

OVERVIEW OF TLA

The goal of Module T-9 is to provide students with an understanding of the impacts of technological decisions. Students will assess current and future technological systems in terms of their social and environmental impacts.



In this TLA students will investigate basic principles of surface science technology. Surface science is the study of contact between solid, liquid, and gaseous materials. Traditional and emerging technologies use this information to address production, environmental, and biomedical problems. Typical problems that surface science technology helps to solve include the dispersing, adhering, and spreading of various materials on or in liquids, solids, and gases. Students will be provided with a scenario concerning an oil spill that will affect the environment. They will attempt to contain the oil spill using knowledge gained through earlier experimentation. Students will also debate local, national, and global technological issues related to the present and the future.

EQUIPMENT AND SUPPLIES

- Plate glass and Teflon surfaces
- Denatured and rubbing alcohol
- Talcum powder, liquid detergents
- Motor oil, mineral oil
- Coatings (glaze, veneer, photoemulsion)

PROCEDURE FOR THIS ACTIVITY

Days	POs*	Teacher Activity	POs*	Student Activity
2	1a 1b	Identify and present information on how futurists 100 years ago envisioned our society today. Define the term futurist and direct a classroom discussion that will have students conclude that we live in a futuristic society compared to those who have come before us. Present information on the role of people as futurists. Provide a list of futuristic forecasts to students and direct a discussion about why these forecasts are useful to society.	1a 1b	List as many present day systems of technology as possible that did not exist 100 years ago. Define the word futurist and participate in classroom discussion. Discuss the role of people as futurists and give example of why futuristic forecasts are useful to society.
	1c	Present information on emerging technologies in the three aspects of technology and facilitate students' learning so that they conclude that biologically related technology includes many of these emerging technologies.	1c	List examples of emerging technologies for the three aspects of technology. Determine how many are in the area of biologically related technology.
2	1d 3a 3b	Direct and facilitate a discussion on socio-technological impacts of specific problems on a local, national, and global level.	1d 3a 3b	Participate in Future Bowl Activity (see Appendix 6).
	1b PO1	Present information on futuring techniques such as trend analysis, future wheel, and evolutionary timelines to the future.	PO1 1b	Choose a technological system in each of the aspects of technology and predict an impact in the future using a futuring technique. List other futuring techniques and explain their use.
	2a-e	Present information on changes in society: new jobs created, obsolete jobs, transferable skills, educational requirements, flexible work attitudes, and changes that are a result of changes in jobs.	2a-e	Take notes on information provided; these notes will be used to help complete homework assignment.
	PO2	Explain and assign Homework Assignment Sheet (Appendix 7). Assign Career Search (Appendix 8).	PO2	Complete Homework Assignment. Complete Career Search.
1	3b 3c 3d	Present information on biologically related technology, specifically biomedical developments, materials used, and the role of surface science technology in developing devices and materials for this area (see Appendix 2).	3b 3c 3d	List examples of how surface science technology has been used in biomedical developments. Conclude that surface science technology is an emerging technology that holds great promise for the future.
3	3e 3f	Demonstrate the experiments to be performed by students and review procedure for recording results. Help students to perform experiments, record data, and draw desired conclusions.	3e 3f	Take notes on the procedure for experiments. Perform surface science experiments, record data, and draw conclusion.

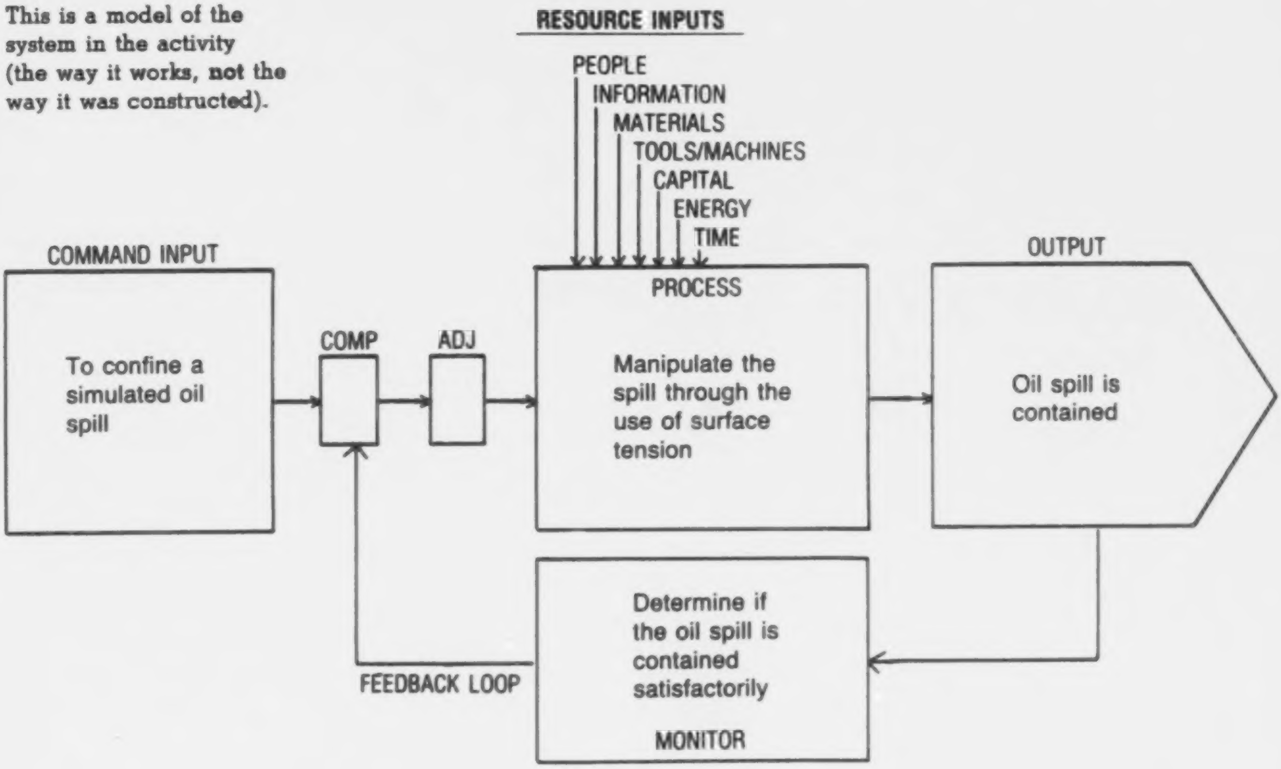
Days	POs*	Teacher Activity	POs*	Student Activity
	PO3	Assign students to model solutions to the problem of containing an oil spill.	PO3	Model a solution to containing an oil spill.
2		Demonstrate method of graphing results of experimentation. Summarize module.		Graph data from experimentation
10 Total Days				

*See Syllabus for phrasing of performance objectives and supporting competencies.

CONSTANTS FOR INFUSION INTO THE TLA

1) SYSTEM OF TECHNOLOGY

This is a model of the system in the activity (the way it works, not the way it was constructed).


RESOURCE INPUTS
PEOPLE
INFORMATION
MATERIALS
TOOLS/MACHINES
CAPITAL
ENERGY
TIME
COMMAND INPUT
To confine a simulated oil spill
COMP
ADJ
PROCESS
Manipulate the spill through the use of surface tension
OUTPUT
Oil spill is contained
Determine if the oil spill is contained satisfactorily
MONITOR
FEEDBACK LOOP

IDENTIFY THE ROLE OF THE FOLLOWING RESOURCES IN THE SYSTEM ABOVE: PEOPLE, INFORMATION, MATERIALS, TOOLS & MACHINES, CAPITAL, ENERGY, TIME.

2) MATH - Approximating the measures of contact angles, in degrees, of liquids placed on different surfaces. Contact angle is measures by "eyeing" the bubble formed on the surface and by imagining a tangent drawn to the bubble. Graphing data gathered from experimentation, analyzing information, drawing conclusions, and making predictions based on data.

3) SCIENCE - Surface science is the study of contact between liquid, solid, and gaseous materials. This is a relatively unknown area of science that has developed far-reaching technological breakthroughs, especially in the biomedical field. The experimentation performed by students in this TLA will follow procedures used in science.

density = mass/volume

specific gravity = density of substance/density of water

4) HUMAN & SOCIAL IMPACTS - Artificial joints, heart valves, arteries, and other components to repair the human body. Cleaning up toxic waste and pollution. Longer life expectancy. Ethical questions about who should receive replacement parts for the body. Genetic engineering, cloning, etc.

5) COMMUNICATION SKILLS - Interaction in Future Bowl Activity (Appendix 6). Recording data from experimentation.

6) SAFETY AND HEALTH - Safe use of equipment and materials in experiments. This TLA relates directly to biomedical devices that are used to promote good health and correct problems with the human body.

7) PSYCHOMOTOR SKILLS - The activity will require fine motor skills in performing experiments. Students will have to place liquids carefully on various surfaces and observe the results. They will have to graph the results of the experiments.

8) CAREER RELATED - Careers in biologically related technology such as the biomedical field, medicine, prosthetic device development; environmental and pollution control; actuary, forecaster.

9) CREATIVE PROBLEM SOLVING - Students will have to identify and define problems related to the future in the Future Bowl Activity. They will propose creative solutions to problems in classroom discussions.

10) TRANSFER OF LEARNING - Students will relate the information and experiences provided in this TLA to their futures and therefore be more in control of their own destinies.

BACKGROUND REFERENCES AND RESOURCES

Much of the material for this TLA is too new to be found in existing text and reference books. Good sources of information will be newspapers and periodicals that keep track of the latest developments.

Baier, Robert and Meyer, Anne. "Biosurface Chemistry For Fun and Profit," *Chemtech,* March 1986, pp. 178-185.

Hacker, Michael and Barden, Robert. *Technology in Your World.* Albany, NY: Delmar Publishers, 1987, pp. 293-325. Student and teacher reference (biotechnology-biomedical)

Heiner and Hendrix. *People Create Technology.* Worcester, MA: Davis Publications, 1980. Student - teacher reference (historical perspective to present)

Pytlik, Lauda, and Johnson. *Technology, Change and Society.* Worcester: MA: Davis Publications, 1985. Teacher reference only (futuring perspective)

"Sludge Busters," *Popular Science,* February 1987, pp. 43-44.

Booklet: "New York State Center For Advanced Technology" available through the New York State Science and Technology Foundation, 99 Washington Avenue, Albany, New York 12210.

EVALUATION

The teacher should develop a two component evaluation system to determine if the student understands: (1) performance objectives and (2) skills, attitudes, knowledge & safety related to the specific lab activity.

EVALUATION OF PERFORMANCE OBJECTIVES (Examples)

1. Define the term "futurist." 1a

2. Explain the meaning of an emerging technology. List one emerging technology for each aspect of technology. 1c

3. Give an example of how having a transferable skill can result in continued employment. 2f

4. Have changes in jobs brought on by emerging technologies caused changes in the way we live and work? Explain. 2c

5. Have emerging technologies helped to eliminate certain jobs? How? 2b

EVALUATION OF SURFACE SCIENCE ACTIVITIES (Examples)

1. Surface science has been used to solve many problems in each aspect of technology. List one problem from each aspect of technology that has been solved.

2. Was a solution found in containing the oil spill? If so, explain.

3. List several safety precautions that should be exercised when performing surface science activities.

4. What is a contact angle? How could a surfact scientist use this information to solve a real-life problem?

5. Why was talcum powder used as part of the experiment?

APPENDIX 1: SURFACE SCIENCE TECHNOLOGY ACTIVITIES

The following are examples of surface science technology activities.

1. Applying a self-leveling finish (for example, Envirotex epoxy resin) to wood or metal
2. Hot rolling a design logo or letters on plastic
3. Using thermographic powder to raise letters in printing
4. Plating of metal
5. Applying a photo emulsion to various surfaces, expose, and develop (e.g., Liquid Light - Pitsco catalog)
6. Glazing on clay
7. Putting porcelain enamel on metal
8. Developing and testing coatings on glass to attempt to produce high performance glass
9. Laminating of plastic
10. Veneering wood
11. Screen printing on paper or fabric

APPENDIX 2: INFORMATION SHEET ON SURFACE SCIENCE/ BIOMEDICAL MATERIALS

Surface science can be defined as the study of contact between liquid, solid, and gaseous materials. Thus, surface science can relate to just about everything that makes contact with something else. Surface science developed from surface chemistry and physics in the late 1800s and early 1900s. Recent developments that have been promoted by surface science technology include:

Pollution control - materials that will push pollutants in one direction across the surface of water, allowing them to be collected and removed more easily. Safe materials have been developed to repel barnicle buildup on ships. Old materials used for this purpose polluted the water the ship sailed in and were not as effective.

Biomedical devices - extended wear contact lenses, Teflon coatings on artificial joints (hip, knee) that make the joint work easier and reduce the rejection factor common with stainless steel joints; use of Teflon tubing as an artery replacement; use of umbilical cords as artery replacements; artificial heart valves, artificial hearts, hogs' heart valves as replacements in humans; materials that help reduce plaque buildup on teeth.

Production - formulation of emulsions in latex paints, self-leveling paints and finishes, printing inks, detergents that do not have to be rinsed off, more effective rustproofing materials for cars.

APPENDIX 3: EXPERIMENT DESCRIPTION AND PROCEDURE SHEET

STATEMENT OF THE PROBLEM: To analyze and compare the adhering, dispersing, and spreading of materials on or in liquids and solids.

MATERIALS

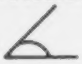
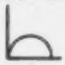
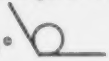
1) plate glass sheets or microscope slides
2) silicone spray
3) paraffin
4) small container (4" x 4") to hold water
5) mineral oil
6) isopropyl (rubbing) alcohol
7) denatured alcohol
8) Dawn dishwashing liquid
9) motor oil
10) talcum powder
11) eyedropper
12) water
13) Keri Lotion
14) generic brand dishwashing liquid
15) Teflon surface
16) Data Collection Sheet (Appendix 4)

PROCEDURE

1. Clean three glass surfaces with a mild detergent and rinse clean. A final wipe with alcohol will assure that the glass is clean.
   Note: Avoid touching the glass surface after it has been cleaned, as the oil from fingers may affect test results.

2. Using the silicone spray, lightly spray an even coat on a glass surface. Repeat the procedure with the paraffin.

3. (a) Place one separated drop of each of the following on a clean glass surface: mineral oil, water, and denatured alcohol. Measure the contact angle for each liquid. Record the results on Data Collection Sheet.

   Ex. 45°  90°  120° 

   (b) Place one drop of mineral oil, water, and denatured alcohol on the silicone coated glass surface. Measure the contact angle for each liquid. Record the results.

   (c) Place one drop of mineral oil, water, and denatured alcohol on the paraffin coated glass surface. Measure the contact angle for each liquid. Record the results.

   (d) Place on drop of mineral oil, water, and denatured alcohol on a Teflon surface. Measure the contact angle for each liquid and record the results.
   Note: Additional tests could be performed on aluminum foil, waxed paper, and various weights of paper.

4. Using the small tray (4" x 4"), fill it with ordinary tap water. Shake a light coating of talcum powder on the surface of the water. Individually test isopropyl (rubbing) alcohol, mineral oil, Keri Lotion, and Dawn dishwashing liquid by placing 1 or 2 drops into the water; record what takes place.

5. Use the results obtained in step 4 to deal with a real life problem. An oil tanker has just spilled thousands of gallons of oil in the Atlantic Ocean. Dead fish are washing up on shore, beaches are closed, food supplies are in danger, and water birds are covered with oil. It is up to you to confine the oil spill in the smallest possible area. Using your knowledge from the talcum powder testing, try to confine the spill. Remember, some of the materials that worked with the talcum powder may react differently with oil. In a clean container of water, place a few drops of motor oil on the surface of the water. Attempt to move the oil slick in one direction. This will simulate one method used to help contain oil spills on water in our environment. List some other methods that are used to contain oil spills.

APPENDIX 4: DATA COLLECTION SHEET

LIQUIDS ON SOLIDS

1. Record the results (in terms of contact angles) of liquids placed on a clean glass surface.
   water ____________
   mineral oil ____________
   denatured alcohol ____________
2. Record the results (in terms of angles) of liquids placed on a glass surface with a coating of silicone.
   water ____________
   mineral oil ____________
   denatured alcohol ____________
3. Record the results (in terms of angles) of liquids placed on a glass surface with a coating of paraffin.
   water ____________
   mineral oil ____________
   denatured alcohol ____________
4. Record the results (in terms of angles) of liquids placed on a Teflon coated surface.
   water ____________
   mineral oil ____________
   denatured alcohol ____________

QUESTIONS:

1. Which materials seemed to spread rather than bead up?

   ____

2. Did any material react totally differently on any of the glass surfaces?

   ____

3. What is surface tension? ____
4. Why would a surface scientist need to compile data such as these?

   ____

LIQUIDS ON LIQUIDS

1. Record the action that took place when different materials were placed on the talcum powder covering the water in the dish.
   1. isopropyl alcohol ____
   2. mineral oil ____
   3. Keri Lotion ____
   4. Dawn dishwashing liquid ____
   5. bargain brand dishwashing liquid ____

APPENDIX 4: DATA COLLECTION SHEET (Continued)

Questions:

1. Were the results of the isopropyl alcohol long lasting? ________
   Why? ________
2. Did the Keri Lotion and mineral oil obtain the same results? ________
3. What is the main ingredient in Keri Lotion? ________
4. Why did Keri Lotion outperform mineral oil? ________
5. Define dispersement. ________
6. Did the generic brand detergent and Dawn react the same? ________
   Why or why not? ________

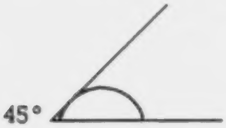
7a. What materials caused the talcum powder to move to the side of the container? ________

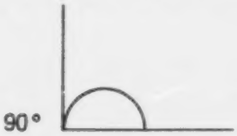
b. What materials caused the oil to be moved to the side of the container? ________

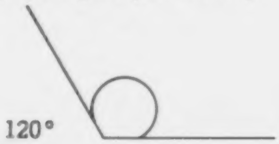
8. How could materials that cause things to move on the surface of water be used to contain something like an oil slick?
____

APPENDIX 5: ADDITIONAL INFORMATION ON THE EXPERIMENT

1. Surfaces coated with paste wax and buffed could be used for measuring contact angles of various liquids.
2. Contact angles of the various liquids are measured by eyeing the bubble that is formed on the surface. The higher the bubble, the greater the surface tension is on that liquid. The measurement is a relative estimate of the surface tension. In a surface science laboratory, instruments are used to measure the contact angle. The contact angles of 45, 90 and 120 degrees are based on a line tangent to the bubble produced by the liquid (see below).







Contact angles of 120 degrees are rare and will occur only with certain liquids on Teflon or similar surfaces.

3. The talcum powder that is spread on the water surface is used to show how various liquids will react to move the powder or other materials on the surface. It may be necessary to change the water and talcum powder after several liquids are added because the surface may become too contaminated.
4. When using alcohol (either type), the effects of the alcohol will be short lived as it evaporates from the water / talcum powder surface.
5. Some dishwashing detergents, such as Dawn, contain wetting agents that will help drops of water roll off dishes to prevent spotting. When these detergents are placed next to oil they will tend to push the oil in the opposite direction. As they mix with the oil, the detergent will disperse the oil into small, separated bubbles.

APPENDIX 5: ADDITIONAL INFORMATION ON THE EXPERIMENTS (Continued)

6. Water that is dropped from aircraft to put out forest fires contains wetting agents.

7. Experimenting with talcum powder covered water:
   - denatured alcohol - moves the powder out in a star pattern.
   - isopropyl (rubbing) alcohol - forces the powder away from where alcohol drop is placed on surface.
   - generic brand detergent - spreads out powder and tends to cause the powder to drop in the water as sediment.
   - brand name detergent (Dawn, Ivory) - pushes powder away from where detergent enters water - powder immediately drops as sediment.

8. Results to expect with oil on water:
   - denatured alcohol - spreads oil into little droplets but in no specific direction. This effect does not last because of evaporation.
   - isopropyl (rubbing) alcohol - forces oil in one direction away from where the alcohol entered the water. Effects do not last.
   - generic detergent - moves oil to one side.
   - brand name detergent - moves the oil faster.

9. There is a product on the market available through swimming pool supply stores called Surface Magic. This product is designed to move leaves and other materials on the pool surface toward the filter. If you can locate this product, allow students to test it on the oil spill.

10. A clear glass dish, filled with water and placed on the overhead projector screen, can be used to demonstrate the activity to a large class.

11. Oil eating bacteria have been produced and are used to help contain and remove some oil spills.

APPENDIX 6: FUTURE BOWL ACTIVITY

DIRECTIONS

Step 1. Ask for six volunteers to sit in a circle in the center of the class.

Step 2. A seventh chair is placed within the circle.

Step 3. The rest of the class stands or sits around the outside of the circle and chair.

Step 4. The six volunteers are given a technological problem to discuss. They will say whatever they want to say about the social-technological impacts of the problem on a local, national, and global level.

Step 5. A student on the outside who wishes to say something must sit in the empty chair and wait to be recognized by one of the others in the circle. Once recognized, this student can briefly state whatever s/he wants to add, clarify, or question, then must vacate the chair for someone else.

Step 6. Each of the six volunteers who go into the circle will receive 5 points for their part in the activity. Each student who moves to the chair from the outside of the circle and discusses the problem will receive 1 point.

SAMPLE TOPICS FOR DISCUSSION

1. Use the futuristic forecasts that students completed on the Homework Assignment Sheet (Appendix 7).

2. Technology has made many advances in the biomedical field; one of these is the area of heart transplants. Discuss some of the ethical and social problems resulting from this process and argue your point of view.
   Ex. Who should receive transplants: old, young, rich, poor?

3. You own a company that designs and manufactures artificial knee joints. What responsibilities do you have to the public to make sure your product does what it is supposed to do?

4. It will cost billions of dollars per year to prevent acid rain from polluting lakes in the Northeast. Is it worth it? Who pays for it?

5. You own a company that has just produced a new drug that seems to be a cure for some forms of cancer. Should this drug be allowed to go on the market right away? Why? Why not?

6. By the year 2000, the average car will be mostly plastic and will last about 22 years. What are the problems associated with this?

7. By the year 2000, 52% of the world's people will reside in urban centers. That figure may leap to 90 percent by the end of the twenty-first century. What are the problems associated with this?

APPENDIX 7: HOMEWORK ASSIGNMENT SHEET

1. Define **futurist:**

2. Define **transferable skills:**

3. Define **flexible work attitudes:**

4. List a minimum of 10 inventions from each of the three major systems of technology that did not exist 100 years ago.

	TRANSPORTATION	COMMUNICATIONS	PRODUCTION
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			

5. Develop a list of futuristic forecasts concerning biological/biomedical areas of technology that could be defended in terms of social and environmental impact.

6. Dictation equipment in the office has replaced the need for a secretary to be a stenographer. This is a situation where a specific job has been made obsolete. List at least three jobs that have been created because of emerging technologies and three jobs that have been made obsolete because of emerging technologies.

7. Computers have a great influence in present day society. List several ways in which jobs that have been created by the computer have changed the way we live and work. Can you think of other job changes that have had an impact on our society?

APPENDIX: 8: CAREER SEARCH

Using the Occupational Outlook Handbook or a similar resource, have students research careers in emerging or advanced technologies and identify the following:

Job Title ______________________________

Job Description ______________________________

Working Conditions ______________________________

Possible Places of Employment ______________________________

Training, Other Qualifications ______________________________

Earnings ______________________________

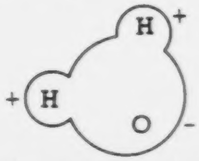
Employment Outlook ______________________________

APPENDIX 9: ADDITIONAL SCIENCE AND SOCIAL SCIENCE CONCEPTS

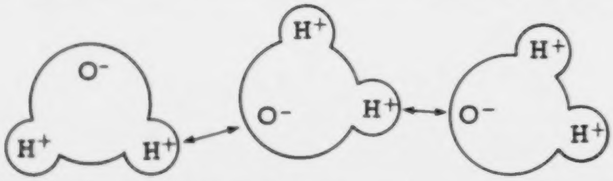
Science

The force which causes water to act as if it has a stretchy skin is called **surface tension.** Surface tension enables water to form round drops. The reason water has a fairly strong tension when compared to oil or soap water is due to its chemical composition.

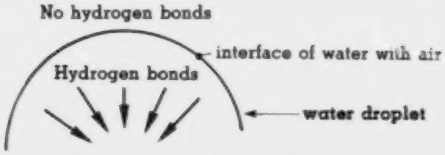
Each water molecule is composed of two hydrogen atoms and one oxygen atom. In the molecule the hydrogen atoms form bonds with oxygen by sharing electrons. The negatively charged electrons are shared unevenly however. The oxygen tends to keep the electrons near it and thus is negatively charged. The hydrogen then tends to be positively charged.



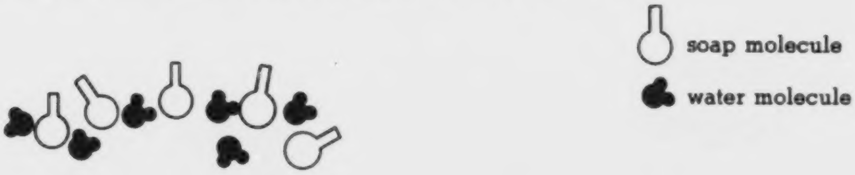
Opposite electric charges (positive and negative) attract. Therefore, the positive hydrogen atoms of one molecule are weakly attracted to the negatively charged oxygen atoms of another molecule. The bonds between the positive hydrogen atoms and the negative oxygen atoms of another water molecule are called **hydrogen bonds.** Hydrogen bonds are not strong bonds.



Because of these hydrogen bonds, the molecules in the center of a water drop are pulled in all ways. Only the water molecules on the surface are pulled in a specific direction, toward the interior of a water drop. This happens because there is no water outside the surface of the water. The pull of hydrogen bonds into the interior of the drop is what causes surface tension.



Thus surface tension causes water drops to be quite rounded in shape. Other liquids such as oil and soap water do not have as great a surface tension. The reason soap water has less surface tension is because hydrogen bonding decreases in strength when the distance between two water molecules increases, and soap molecules come in between water molecules. Thus soap molecules separate water molecules and decrease surface tension.



APPENDIX 9: ADDITIONAL SCIENCE AND SOCIAL SCIENCE CONCEPTS (Continued)

Because water has a strong surface tension and is susceptible to evaporation, water bubbles burst rapidly. Soap bubbles are "better" than water bubbles. The reason is that they only have about 1/3 the surface tension of water and the soap helps protect bubbles from evaporation.

Evaporation is a problem for bubbles. When the water evaporates, the bubble breaks. Thus many bubble solutions contain a substance that keeps water from evaporating. Substances that have water-holding properties are referred to as hygroscopic. Glycerin is a hygroscopic liquid that is added to bubble solutions. Another hygroscopic substance is sugar.

Source: "Bubbles: Film, Foam and Fuzz." *Ideas in Science*. Exploratorium in San Francisco.

Social Science

Over the past 40 years, the chemical industry has expanded enormously. A large market developed for products that were virtually unknown before World War II, including pesticides, solvents, and industrial cleaners. The problem is that as a by-product of their manufacture, the chemical industry generates many hazardous wastes, about 70 percent of all such wastes. Other wastes come from paper mills, textile firms, leather tanneries, and electro-platers. It is estimated that almost 300 million tons of hazardous waste pours out of American factories each year.

For years, many industries dumped their by-products in a haphazard manner. Wastes were disposed of in ponds, underground wells, abandoned mine shafts, or simply discarded in landfills. After years of assuming that these undesirable wastes could simply be thrown away, it has become increasingly clear that barrels eventually begin to leak, that chemicals that were out of sight and mind are now seeping into the water and our food, affecting the environment and our health in many ways. It is reported that 90 percent of the hazardous wastes are not disposed of properly and that as a result of past neglect, there are at least 22,000 potentially dangerous dump sites scattered across the country.

The problem now is to not only determine what to do about cleaning-up these dangerous sites but also come up with a procedure for dealing with hazardous wastes that we produce from now on. There are no easy solutions to the problems, but, as the situation at Love Canal exemplifies, the results of failure to come to grips with these concerns can be catastrophic.

INTRODUCTION TO TECHNOLOGY
TECHNOLOGY LEARNING ACTIVITY

WASTE PROCESSING TECHNOLOGY

MODULE NUMBER: T-9
NUMBER OF DAYS: 15

MAJOR CONCEPTS TO BE ADDRESSED

T-9A Technological systems must be assessed on the basis of their impact on people, society, and the environment.

T-9B Technological evolution can be projected into the future world.

T-9C As emerging technologies replace existing technologies, new industries will develop.

T-9D Work, job opportunities, and careers are in constant change because of the evolution of technology.

T-9E The development of flexible attitudes and transferable skills will increase the adaptability of persons to the rapid evolution of technology.

T-9F The development of leadership and social skills allows individuals to pursue technological careers with higher levels of responsibility.

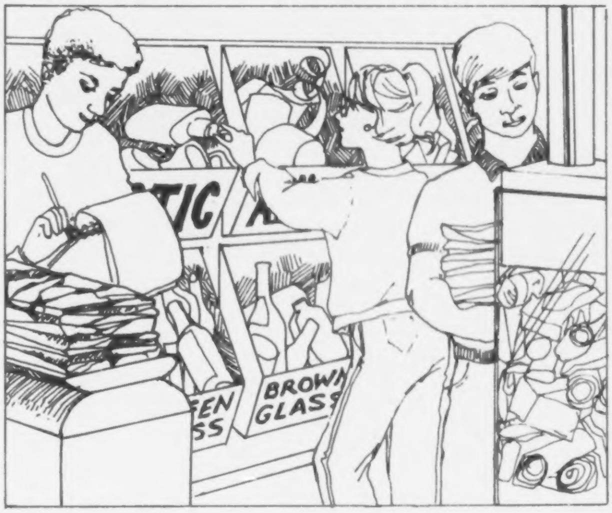
T-9G Technology has an impact on personal, local, national and international issues. These impacts, whether perceived or actual, may take many forms.

T-9H The rapid spread of technology has created world competition for jobs, resources, and markets.

T-9I Technology is making the world interdependent, resulting in the need for more international cooperation by sharing things such as resources, technical expertise, and markets.

T-9J Technological systems must be controlled for the continued well-being of the world.

OVERVIEW OF TLA



From collection of waste to actual recycling processes, students will develop a suitable waste management program for their particular community. By analyzing personal and municipal waste practices, inherent problems or weaknesses can be exposed. Student solutions based upon calculations, investigations, and experiences related to recycling technologies will result in a finalized plan to be proposed for implementation. Experiences will focus on recycling of glass, paper, aluminum, and food wastes.

EQUIPMENT AND SUPPLIES

- Foundry tools and equipment
- Waste materials (paper, aluminum, food, plastic, glass)
- Various containers
- Timing device
- Temperature measuring instruments
- Combustion area with containers, water, ceramic kiln, and accessories
- Plastic forming equipment

PROCEDURE FOR THIS ACTIVITY

Days	POs*	Teacher Activity	POs*	Student Activity
2	PO1	Introductory presentation on the crisis in handling waste. What wrong decisions were made in the past? Who is responsible? What are some considerations for the future?	PO1 1a 1b 1d	Collect and assemble information from journals or other sources to report on current or historical waste problems. Use futuring techniques to project consequences of accumulating waste on a local, national, and global level.
	PO1	Discuss different waste categories and present possible changes in the way that wastes are currently processed. Discuss transportation, separation, enegry conversion, recycling, landfill operation.		Divide into groups and select a waste category to be investigated (paper, glass, plastic, food, aluminum). Begin collecting waste material from home, school, etc.
	1c	Discuss technological processes in each of the three aspects of technology that can be used to assist in the disposal of waste (e.g., sludge-eating bacteria, conversion of biomass into methane, compaction).		Establish a plan for collection, preparation, transportation, and storage of waste material for classroom recycling or conversion activity.
	3a	Guide students in procedures to investigate waste collection practices and characteristics of specified waste material. Weigh, measure, compact, and contain material for use.	3f 3a	Use Worksheet on Waste Planning (see Appendix) to perform assessment procedures and activities. Answer questions about personal, local, national, and global deficiencies for homework. Assemble collected waste at appropriate site in or near classroom.
1	3b	Invite a community representative or refuse industry representative to address the class.	3b	Interview visitor and assess waste technology currently used in the community or region. Describe the social issues surrounding waste disposal. Identify other socio-technological issues.
4	PO3	Using Appendix: Recycling Activities and related research, present possibilities for in-class recycling or energy conversion processes (papermaking, aluminum casting, injection molding, methane gas generation, casting glass, combustion, etc.).	3c 3e 3f	Recycle various materials. Present final product in usable form and compare with previous form as waste material. Document "before and after" with photographs.
1	2b	Discuss jobs to be performed in the implementation of a large-scale recycling or conversion system.	3c 2b 2d PO2	Transfer and apply principles of classroom conversion and recycling activities to a full-scale community or regional application. Prepare a chart of job descriptions, technical specifications, and innovations. Discuss how new methods of waste disposal and/or recycling have created new jobs while making others obsolete.

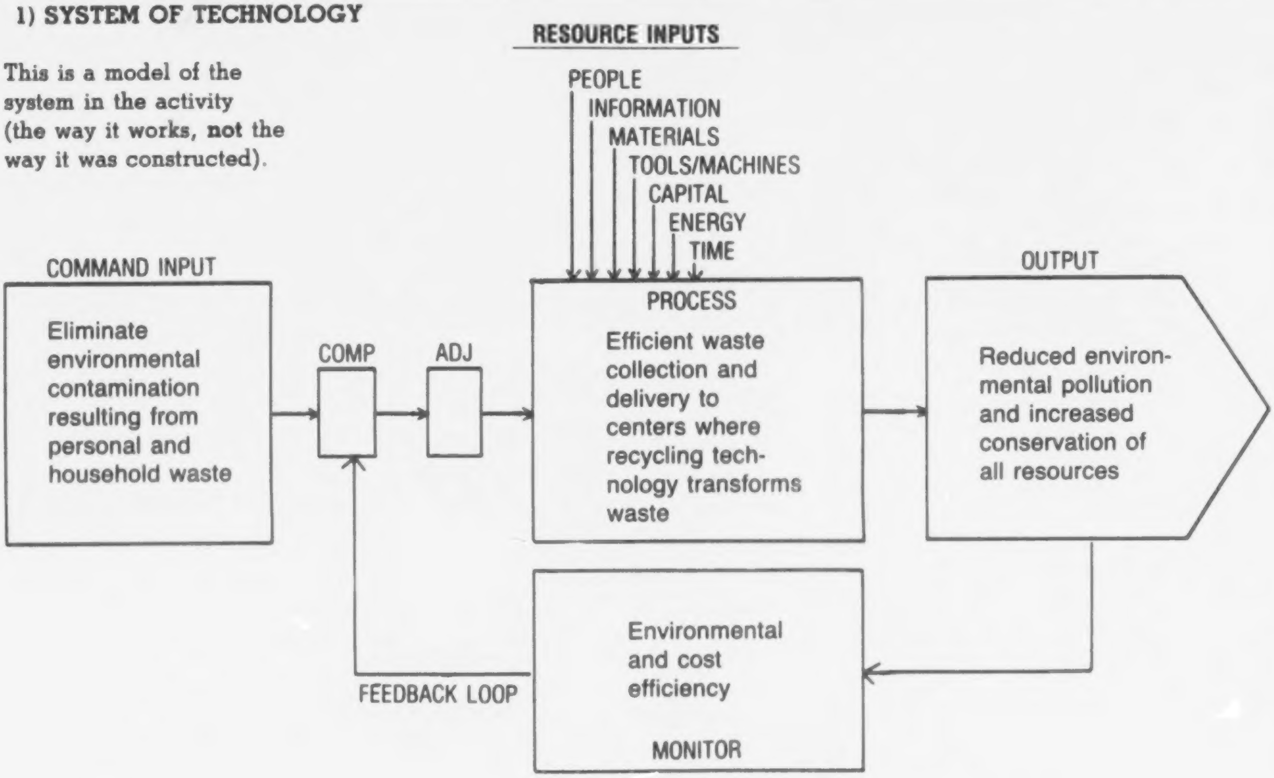
Days	POs*	Teacher Activity	POs*	Student Activity
6	PO3	Guide students in preparing an alternative community waste plan using technical information and experience gained from the recycling or energy conversion experience.	3e 3f	Using sketches and models, design and prepare a documented plan for an alternative community waste system based upon technical concepts and processes derived from recycling or conversion experiences.
1		Invite community residents, local officials, and school personnel to hear student presentations.	PO3	Present alternative waste plan for the community.
15 Total Days				

*See Syllabus for phrasing of performance objectives and supporting competencies.

CONSTANTS FOR INFUSION INTO THE TLA

1) SYSTEM OF TECHNOLOGY

This is a model of the system in the activity (the way it works, not the way it was constructed).


RESOURCE INPUTS
PEOPLE
INFORMATION
MATERIALS
TOOLS/MACHINES
CAPITAL
ENERGY
TIME
COMMAND INPUT
Eliminate environmental contamination resulting from personal and household waste
COMP
ADJ
PROCESS
Efficient waste collection and delivery to centers where recycling technology transforms waste
OUTPUT
Reduced environmental pollution and increased conservation of all resources
Environmental and cost efficiency
MONITOR
FEEDBACK LOOP

IDENTIFY THE ROLE OF THE FOLLOWING RESOURCES IN THE SYSTEM ABOVE:
PEOPLE, INFORMATION, MATERIALS, TOOLS & MACHINES, CAPITAL, ENERGY, TIME.

2) **MATH** - Control of waste management systems, waste recycling processes, and waste conversion processes is heavily dependent upon careful monitoring and calculations of time, temperature, weight, size, volume, and cost.

3) **SCIENCE** - Anerobic digestion, biogas generation, paper, glass, metal, and plastic recycling processes are designed using principles of biology, chemistry, and/or physics.

4) **HUMAN & SOCIAL IMPACTS** - A comparison between continued landfill site expansion and waste recycling technology will expose the associated drawbacks of some current practices and the potential benefits of alternative measures.

5) **COMMUNICATION SKILLS** - Contact with community officials and waste management personnel. Documenting information by using script, photography, and/or video recording. Understanding and promoting alternative waste technologies.

6) **SAFETY AND HEALTH** - Exposure to current event coverage in newspapers, magazines, and television concerning the dangers of outdated waste management technology will increase student awareness of the potential hazards that inefficient waste treatment imposes on human well-being.

7) **PSYCHOMOTOR SKILLS** - Construction and/or operation of waste recycling systems and equipment will involve extensive hand-eye coordination.

8) **CAREER RELATED** - Changes in waste management technology have created numerous new job classifications in relation to refuse collection, management of waste systems, and engineering and design of additional innovations.

9) **CREATIVE PROBLEM SOLVING** - Opportunities for creative problem solving will be provided by this TLA, including identification and definition of a problem, goal and criteria setting, generation of alternative solutions and recognition of limitations, optimization, testing, and evaluation.

10) **TRANSFER OF LEARNING** - By understanding concepts and examining consequences of current and past waste management practices, students can make informed decisions about potential future waste management problems.

BACKGROUND REFERENCES AND RESOURCES

Anderson, Larry L. and Tillman, David A. *Fuels from Waste*. New York: Academic Press, 1977.

Bruce, A.M., Kouzeli-Katsiri, A. and Newman, P.J. *Anerobic Digestion of Sewage Sludge and Organic Agricultural Wastes*. New York: Elsevier Applied Science Publishers, 1986.

Emcon Associates. *Methane Generation and Recovery from Landfills*. Ann Arbor, Michigan: Ann Arbor Science Publishers, 1982.

Kelly, Katie. *Garbage: The History and Future of Garbage in America*. New York: Saturday Review Press, 1973.

Library of Congress. *Papermaking: Art and Craft*. Washington: Library of Congress, 1986.

Parker, Colin and Roberts, Tim. *Energy from Waste: An Evaluation of Conversion Technologies*. New York: Elsevier Applied Science Publishers, 1985.

Shanks, Ann Zane. *About Garbage and Stuff*. New York: The Viking Press, 1973.

EVALUATION

In an oral and/or written presentation, the student will be graded on the validity of logic used to defend a proposed alternative to the current waste management system.

In addition, students may be evaluated on responses to questions similar to the examples below.

1. Briefly describe the technological process used to recycle the type of waste material which was assigned to your group.

2. Draw a labeled systems diagram describing how a waste recycling system functions.

APPENDIX: WORKSHEET ON WASTE PLANNING

TYPE OF WASTE: ____________________

Total number of people generating collected waste ________

	Weight	Initial Volume	Compacted Volume
Day #1			
Day #2			
Day #3			
Day #4			

TOTALS

What is the average weight of the garbage generated per person in one week? ____ a year? ____ 50 years? ____

What is the total volume of garbage generated per person in one week? ____ a year? ____ 50 years? ____

If the selected garbage material is compacted, what is the resultant volume generated in one week? ____ a year? ____ 50 years? ____

Is it possible to compact the waste material further?

Using the above information, calculate the amount of garbage from your selected category that is generated by your community in one year.

List several environmental or management problems derived partly from the information above.

What implications do these problems have for you, your community, and the world?

What transportation methods are currently used for waste removal in your community?

How would transportation needs change if all of the waste material in your community were to be recycled?

Are there nearby facilities or transportation networks for handling the recycling process? If not, what might be some suggestions for beginning development?

What factors are important in successful recycling systems that are economical and ecological?

APPENDIX: RECYCLING ACTIVITIES

CONVERSION OF FOOD/METHANE GENERATION: Using waste food from the school cafeteria, discover how methane gas may be produced.

Basic Materials - food scraps, livestock manure, mixing apparatus, water, two 5 or 10 gallon containers, balloons or innertubes, valves

Questions:

Is there any non-usable waste derived from this process?

What application does the effluent have?

How can industry use waste to generate energy? For what purposes?

Is the methane gas that is derived from waste any different than that derived from other sources?

Are there any potentially harmful or dangerous effects resulting from waste conversion to methane gas?

CONVERSION OF PLASTIC/COMBUSTION: By burning identical weights of different kinds of thermoplastics, determine the combustion efficiency by measuring which plastic raises the temperature higher in a given amount of water.

Basic Materials - shredded or pelletized plastic containers, fume hood for venting, 16, 24, or 32 ounce containers, safe combustion vessel or area, matches, photothermometer, timing device

Questions:

Compare the potential hazards of burning plastic materials for energy conversion vs. burning paper or wood.

Do you think that it would be better to bury plastic materials in a landfill or burn them for energy conversion applicatons? Why?

Can negative impacts of plastic combustion be neutralized?

How has the extensive use of plastics saved energy?

APPENDIX: RECYCLING ACTIVITIES (Continued)

RECYCLING PAPER/PAPERMAKING: Use newspapers, magazines, rags, etc. to form new paper from pulp.

Basic Materials - pulverizing mechanism and/or tools, vat, mold, water, sizing material, bleach, waste paper

Questions:

How do different types of waste paper products entered into the recycling process affect the final product?

If there are undesired results in product quality or form, how can they be corrected?

In terms of environmental and social impacts, compare this recycling process with making paper from raw materials (wood).

What specific immediate or future hazards may result from current recycling technology?

Describe how technological developments have changed the process of recycling paper.

How can raw materials used in the paper recycling process be recovered or conserved?

CONVERSION OF PAPER/COMBUSTION: By burning identical weights of different kinds of paper products, determine the combustion efficiency by measuring which paper raises the temperature higher in a given amount of water.

Basic Materials - 16, 24, or 32 ounce containers, safe combustion vessel or area, room temperature water, matches, photothermometer, paper samples

Questions:

What are the positive or negative impacts of using paper for conversion into energy?

Are the impacts immediate or realized in the future or both?

Can any negative impacts of paper combustion be neutralized? How?

What are the advantages of this process over the use of landfills?

APPENDIX: RECYCLING ACTIVITIES (Continued)

ALUMINUM RECYCLING/CASTING: Using aluminum cans, melt a batch of aluminum in a foundry area. Cast the molten aluminum into a new and usable product.

Basic Materials - mold pattern, foundry equipment, scrap aluminum

Questions:

Can similar recycling be accomplished with other metals?

How does this process differ from making aluminum, steel, brass, or copper from natural raw materials?

In terms of present or future environmental impacts, what are the differences between recycling and manufacture from raw materials?

Describe technological developments that have changed the metal recycling process.

Is metal recycling more beneficial than another method of handling metal waste?

GLASS RECYCLING/FORMING: Using crushed glass from garbage at home, melt the glass in a suitable gas forge and form it into a new and usable shape.

Basic Materials - molds, safety clothing, tongs, gas-fired forge, crushed glass, crucible

Questions:

Are all glass products alike?

Does your recycled glass exhibit different characteristics than it did in the original form?

Compare the making of glass by recycling with production by using raw materials.

Explore new job possibilities that would result from extensive adoption of glass recycling.

Compare the cost for securing and transporting waste glass for recycling with the cost for mining and transporting raw materials.

APPENDIX: RECYCLING ACTIVITIES (Continued)

RECYCLING OF PLASTIC: Using waste thermoplastics from product containers in the home, shred or pelletize and form into a new usable product by any of several plastic forming processes.

Basic Materials - shredding mechanism, heat source, container, injection molder, extruder, blow molder, etc., plastic scraps

Questions:

How would reliance upon plastic recycling affect the world oil supply or the cost of gasoline for our automobiles?

What are some future impacts if extensive plastic waste recycling is adopted?

What kinds of jobs may be created or eliminated with increased use of plastic recycling?

APPENDIX: ADDITIONAL SCIENCE CONCEPTS

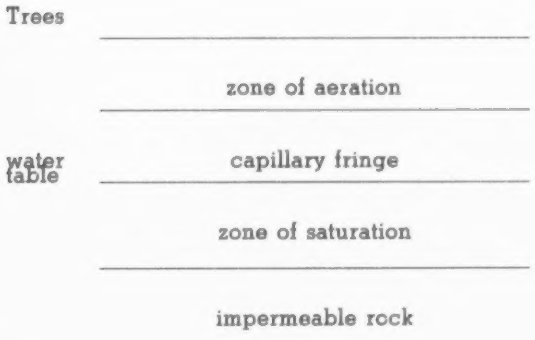
Science

The amount of solid waste being produced is increasing. At the same time, locations for storing this solid waste are decreasing. Solid wastes may be dumped in the ocean, causing pollution. It may be burned, but if proper care is not taken, air pollution may result. Some communities are using the heat from incineration to produce electricity. Solid waste may also be placed in open dumps or in sanitary landfills.

Sanitary landfills require that the waste be spread out and covered daily with a layer of soil about six inches deep. Some common landfill sites are abandoned quarries, gravel pits, strip mines, canyons, and swamps.

Prior to establishing a sanitary landfill, certain studies of the land should be made such as the locations of bedrock, the water table location, the types of soil, and the drainage area.

Subsurface water can be divided into zones.



Impermeable rock does not allow water to pass through it.

The zone of saturation is the layer of soil holding as much water as it can possibly hold.

The water table is the top of the zone of saturation.

Groundwater is water found in the zone of saturation. If a hole is dug down below the water table, the hole will fill up with water to the level of the water table.

APPENDIX: ADDITIONAL SCIENCE CONCEPTS (Continued)

Sanitary landfills should be located so that they are above the water table. The formation below the landfill should be impermeable enough to prevent downward seepage into the water table with the resultant pollution of groundwater. Groundwater is a source of drinking water for many people in New York. An aquifer is an underground storehouse of groundwater. On Long Island alone, three million people obtain drinking water from the Long Island aquifer. Another one million people obtain drinking water from groundwater in upstate New York. If a landfill is built in permeable sand and gravel, the pollutants can leach down through the soil and reach the groundwater.

The topography of the land should also be considered. Flooding could cause problems if it reaches a landfill area. Flooding will also increase the rate of travel of ground pollutants to the water table.

INTRODUCTION TO TECHNOLOGY TECHNOLOGY LEARNING ACTIVITY

COMPUTER CONTROL

MODULE NUMBER: T-10
NUMBER OF DAYS: 30

MAJOR CONCEPTS TO BE ADDRESSED

T-10A The same systems model which is used to diagram individual technologies is an effective problem-solving tool.

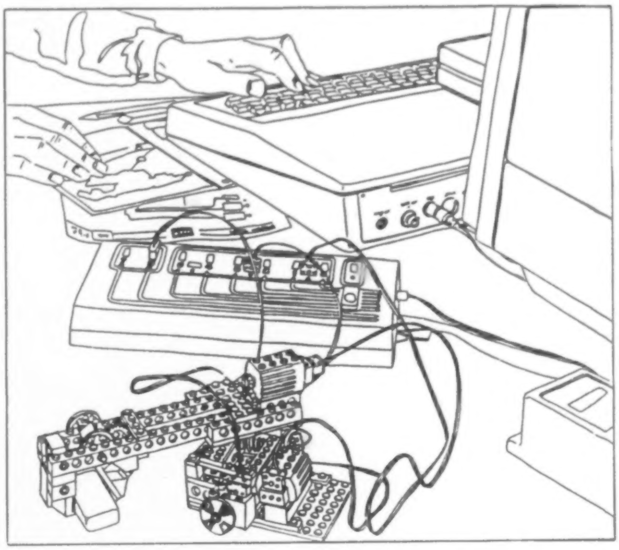
T-10B The solutions to practical problems often involve a combination of subsystems from different aspects of technology.

T-10C Computers, as tools, can be used to store and retrieve information.

T-10D Computers are tools which may be used by people to help decide upon a solution to a problem as well as to implement a solution to a problem.

OVERVIEW OF TLA

The students will use the systems model as a problem-solving tool. They will design and develop solutions to real-life technological problems. Using LEGO® and TC LOGO components the students will design, develop, and operate complex systems which may count, determine size, and/or sort objects. Subsystems of these systems such as conveyors, vehicles, and traffic controls will also be addressed. The computer will be used for control, programming, and record keeping. Students will be asked to draw upon their previous understanding of the different elements of the systems theory in order to solve an assigned probelm creatively using LEGO® and TC LOGO components.



EQUIPMENT AND SUPPLIES

- LEGO® /LOGO computer-based systems
- LEGO® /LOGO software
- LEGO® building systems with:
    - optosensors
    - touch sensors
    - conveyors
    - motors
    - lights
- Apple IIe computer system with printer
- Word processing software

PROCEDURE FOR THIS ACTIVITY

Days	POs*	Teacher Activity	POs*	Student Activity
1		Collect pictures, slides, VHS tapes, and models of actual systems familiar to the students. Collect real-life examples of the systems that will be constructed using LEGO® Technic and LEGO® TC LOGO systems. (Examples: washing machine, traffic light, electric eye)	1b-f 2b	Categorize systems shown according to each aspect of technology. Fill in a systems diagram for one of the systems shown. Homework: Pick two of the systems and fill in the blocks in the systems diagram. (See Appendix: Systems Diagram.)
1	1a	Show the similarity of the problem-solving model in T-3 to the basic systems model. Explain how the systems model could be used to solve problems. Present a problem consisting of transfer of materials and the recording of the number of materials transferred (LEGO® activity card TK).	1a 2a 2b	Diagram the problem-solving systems model (see Appendix: Problem Solving). Explain how the system is monitored and controlled. Fill in the diagrams using LEGO® materials to solve a problem.
1	2b	Review sensors that are used to control feedback. Include LEGO® TC sensors. Operate a system using feedback. (Example: LEGO® touch sensor vehicle)	2b 1g	List systems that use feedback and explain how they are controlled. Include LEGO® touch sensor, optosensor, counter, and LEGO® TC LOGO computer control. Describe ways of adjusting system output.
2		In groups, give students problems to solve. Categorize problems by level of difficulty. Assign a problem to the student groups using LEGO® Technic II for easier problems and LEGO® TC LOGO for advanced level problems (see Resources for other materials).	PO1 2a	Use the problem-solving systems approach to solve the problem. Define the problem and set goals.
1	3a-e	Review computer use related to record keeping. Demonstrate appropriate software to store mathematical and other technical data.	3a-e	Become familiar with computer programs. Input sample data and operate a printer.
3	PO3	Facilitate use of computers for record keeping.	PO3	Begin storing data used and progress made in designing and developing the system.
3	2b	Introduce subsystems. Supply students with LEGO® sensors, gears, motors, LOGO programs, and controls needed to solve the problem.	2b 1g 2c	Assemble the sensor portion of the system and test the feedback, using the computer as needed. (Use LEGO® Getting Started, Making Machines, and Teaching the Turtle for reference. See appendices.) Develop alternatives and select the best solution for sensing and control.
11		Facilitate construction of student designed and developed devices.	PO2	Implement the solution by constructing the device.

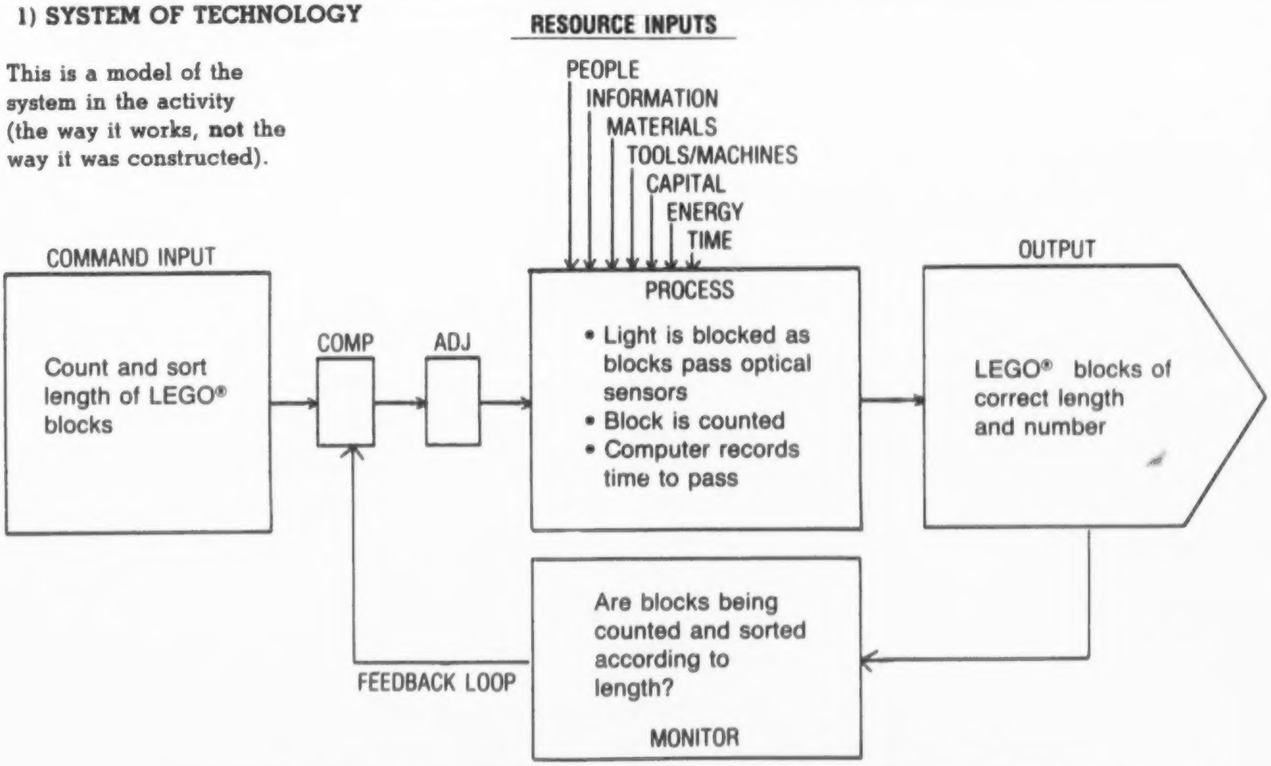
Days	POs*	Teacher Activity	POs*	Student Activity
4		Use LEGO® cards, instruction manuals, and teacher guides as needed for instructions.	1f	Evaluate results and make necessary changes.
2		Facilitate student demonstrations of constructed devices.		Demonstrate device to class. Using overhead projector, present the problem-solving steps and systems diagrams used in solving the assigned problems. Give examples of the system as it is used in familiar situations.
1		Review for test.	PO3	Submit computer document of progress on problem. Take test.
30 Total Days				

*See Syllabus for phrasing of performance objectives and supporting competencies.

CONSTANTS FOR INFUSION INTO THE TLA

1) SYSTEM OF TECHNOLOGY

This is a model of the system in the activity (the way it works, not the way it was constructed).


RESOURCE INPUTS
PEOPLE
INFORMATION
MATERIALS
TOOLS/MACHINES
CAPITAL
ENERGY
TIME
COMMAND INPUT
Count and sort length of LEGO® blocks
COMP
ADJ
PROCESS
• Light is blocked as blocks pass optical sensors
• Block is counted
• Computer records time to pass
OUTPUT
LEGO® blocks of correct length and number
FEEDBACK LOOP
Are blocks being counted and sorted according to length?
MONITOR

IDENTIFY THE ROLE OF THE FOLLOWING RESOURCES IN THE SYSTEM ABOVE:
PEOPLE, INFORMATION, MATERIALS, TOOLS & MACHINES, CAPITAL, ENERGY, TIME.

2) **MATH** - Binary numbers, LOGO computer language, graphing, angles as fractional parts of 360°, $C = \pi d$ or $2\pi r$, computing velocity in feet per second using $rt = d$, fractions, and ratios.

3) **SCIENCE** - Simple machines, mechanical advantage, gears, calibration, measurement tools, centrifugal force.

4) **HUMAN & SOCIAL IMPACTS** - The students will gain an appreciation and understanding of technology as it applies to their everyday lives. This can lead to discussions of controlling and changing systems that they encounter.

5) **COMMUNICATION SKILLS** - Sketching, pictorial drawings, detail and assembly drawings, oral presentations, computer word processing, and computer programming.

6) **SAFETY AND HEALTH** - Relate modeled systems to the safety hazards of operating the real machines.

7) **PSYCHOMOTOR SKILLS** - Eye hand coordination, manual dexterity, visualization of hidden view.

8) **CAREER RELATED** - Insight into the fields of engineering, industrial design, emerging technology.

9) **CREATIVE PROBLEM SOLVING** - Opportunities for creative problem solving will be provided by this TLA including: identification and definition of a problem, goal and criteria setting, generation of alternative solutions and recognition of limitations, optimization, testing and evaluation.

10) **TRANSFER OF LEARNING** - Understand how real systems operate through modeling; use problem-solving method to troubleshoot.

BACKGROUND REFERENCES AND RESOURCES

LEGO® References

Teacher's Guide to Technic I
Teacher's Guide to Technic II
TC LOGO *Getting Started*
TC LOGO *Making Machines*
TC LOGO *Teaching the Turtle*
TC LOGO *Teacher's Manual*

LEGO® supplies of increasing difficulty

Technic I
TechnicII
Universal Buggy I
Manual Control I
Technical Control 0
Technical Control 1
Technical Control 2

For more information, contact:
LEGO® Educational Division
LEGO Systems, Inc.
555 Taylor Road
Enfield, CT 06082
(203) 749-2291
(800) 243-4870

Resources

Apple Logo. Logo Computer Systems, Inc., 1982.

Coffron, James W. *The Apple Connection.* 1982.

Hacker, Michael and Barden, Robert. *Technology in Your World.* Albany, NY: Delmar Publishers, 1987.

Todd, Ronald, McCrory, David, and Todd, Karen. *Understanding and Using Technology.* Worcester, MA: Davis Publications, 1985.

EVALUATION

The teacher should develop a two component evaluation system to determine if the student understands: (1) performance objectives and (2) skills, attitudes, knowledge & safety related to the specific lab activity.

(1) EVALUATION OF PERFORMANCE OBJECTIVES (Examples)

1. Develop a systems diagram of the actual machine or device that was modeled. Diagram a subsystem that is in the actual system. 2b

2. List examples of systems in each aspect of technology. Identify monitoring sensor, comparison device, and adjustment process that are used. PO1, 2b

3. Explain possible results of the above systems if the monitoring sensor is not working properly. 1g, 2b

4. Compile the list of formalized problem-solving steps. Make comparisons to the process steps in the systems diagrams. PO1

5. Develop a drawing of your own formalized problem-solving method which might combine systems and other problem-solving charts. PO1, 2a

(2) EVALUATION OF SKILLS, ATTITUDES, KNOWLEDGE & SAFETY (Examples)

1. Sketch a block diagram using major components of the LEGO® TC LOGO feedback systems which could be used to monitor the following situations:

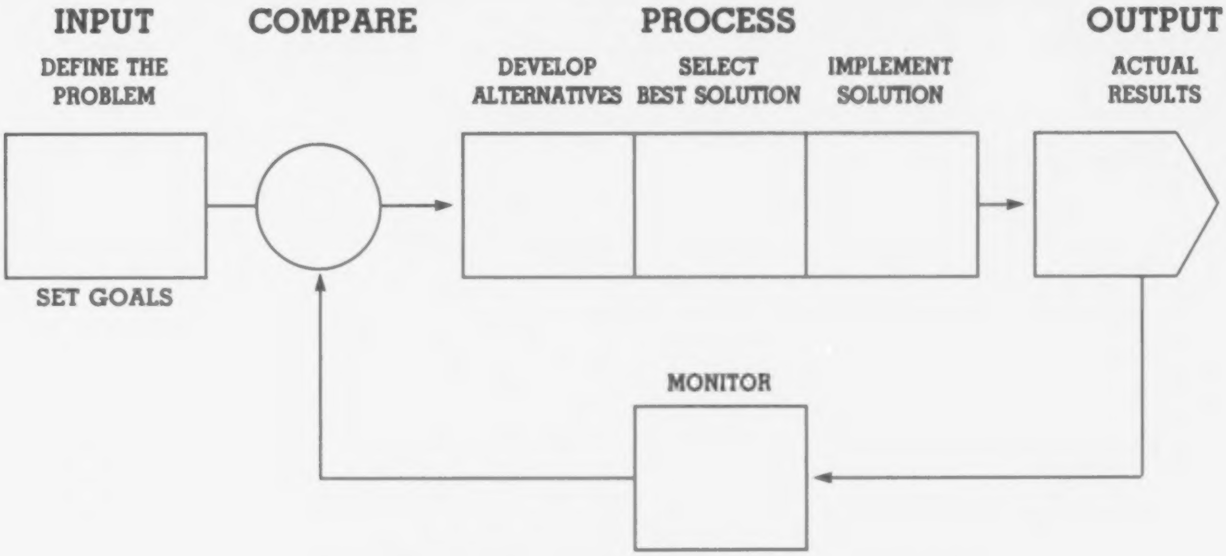
- doorway counter for recording movement of people
- rpm of tires on a vehicle
- CAM counter for counting rpm of machines

2. Identify the following parts from LEGO® Technic II kits and list two places where you would find them in real-life machines or devices: spur gear, idler gear, ratchet and pawl, worm gear, bevel gear, crown gear, pinion, sprocket, pulley, power take off, auger, linkage. (Use pictures or gears glued to a backing material.)

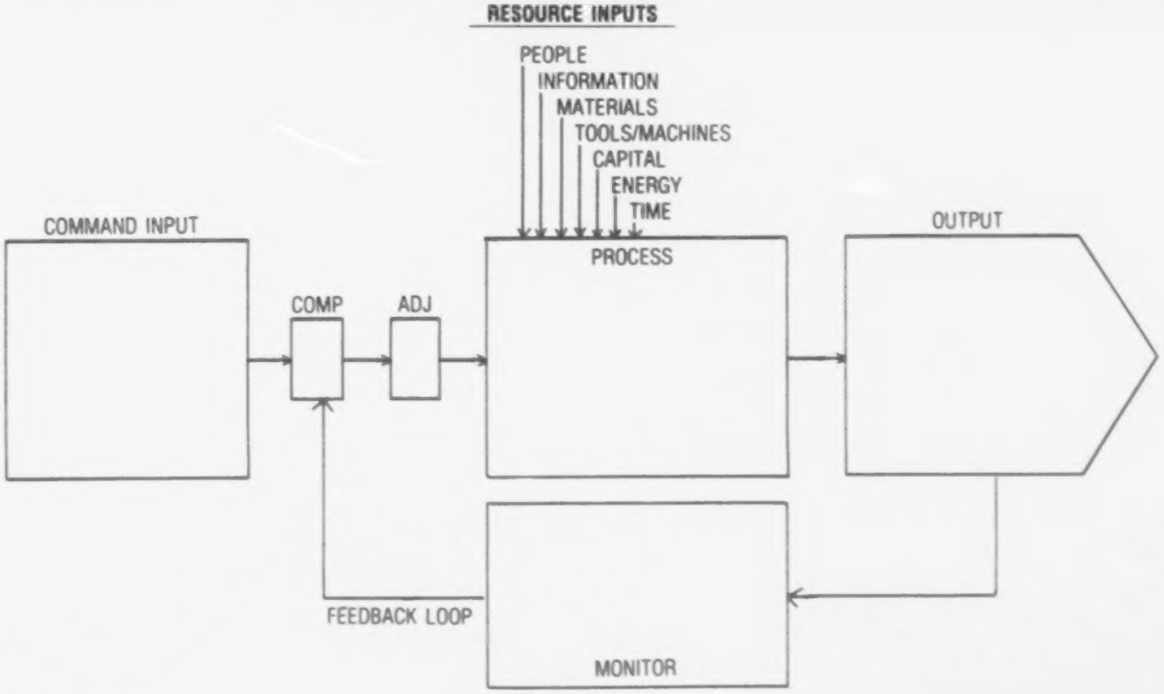
3. List three real-life situations for each of the following LEGO® TC LOGO sensors:

- touch sensor
- optosensor
- indicator lights
- counter

APPENDIX: PROBLEM SOLVING


INPUT
DEFINE THE PROBLEM
SET GOALS
COMPARE
PROCESS
DEVELOP ALTERNATIVES
SELECT BEST SOLUTION
IMPLEMENT SOLUTION
OUTPUT
ACTUAL RESULTS
MONITOR

APPENDIX: SYSTEMS DIAGRAM


RESOURCE INPUTS
PEOPLE
INFORMATION
MATERIALS
TOOLS/MACHINES
CAPITAL
ENERGY
TIME
COMMAND INPUT
COMP
ADJ
PROCESS
OUTPUT
FEEDBACK LOOP
MONITOR

APPENDIX: GETTING STARTED CURRICULUM CHART

Activity	**LEGO® /LOGO Skills**	**New LOGO Primitives**	**Science Concepts**	**Math Concepts**
Soap Box Derby	Basic construction LEGO® building elements Wheels, axles		Simple machines Motion, friction Scientific method Data collection	Measurement Averaging Graphing Time-rate-distance
Motorized Car Using motors	LEGO® motors Gears, pulleys Battery box		Forces Motors, electricity Gears Mechanical advantage	
Motorized Car Computer control	Computer control Simple LOGO	on, off onfor rd, cc talk to	Programming	Time-rate-distance
Traffic Light Programming skills	LOGO Procedures Recursion	repeat wait alloff	Light Color	Codes Binary arithmetic Recursion
Traffic Light Touch sensors	Touch sensors LOGO conditionals	listento sensor? , not waituntil if, ifelse	Animal senses Machine sensors	
Electric eye	Optosensors Computer timer	timer reset	Vision Time Clocks	
"Smart" car Gears	Gear trains rpm		Gears Mechanical advantage	Fractions Ratios
"Smart" car Cars and sensors	Sensors on machines Electronic counter Procedures with inputs	counter resetc	Calibration Measurement tools	Measurement Time-rate-distance

APPENDIX: MAKING MACHINES CURRICULUM CHART

Activity	LEGO® TC LOGO Primitives and Concepts	Science Concepts	Math Concepts
Merry-Go-Round	readchar name tone naming/variables	Circular motion Centrifugal force	Circles Fractions
Washing Machine	or output	Time/clocks Using sensors for safety	Logic Time Codes
Conveyor Belt	count objects determine size sort objects	Intelligent machines Robots	Measurement

APPENDIX: TEACHING THE TURTLE CURRICULUM CHART

Activity	LEGO® TC LOGO Primitives and Concepts	Science Concepts	Math Concepts
Introductory Activities	tfd tbk tlt trt	Motion Time-rate-distance Robots	Measurement Angles Ratios Geometry
Advanced Activities	gofd gobk golt gort offturtle	Intelligent machines Animal senses vs. machine sensors Simulation	Calibration

APPENDIX: ADDITIONAL SCIENCE AND SOCIAL SCIENCE CONCEPTS

Science

Light Energy

Electromagnetic energy is transmitted through space in waves. Visible light waves are a small portion of the electromagnetic spectrum which can be detected by the human eye. Visible light consists of a spectrum of colors: red, orange, yellow, green, blue, indigo, and violet. Red light has the longest wavelength and violet light has the shortest wavelength.

Generally, light travels from a source in straight lines at approximately 3 x 10^5 km/sec. When light strikes a surface, a variety of things may happen depending on the nature of the surface. For example, if it strikes an opaque object, the object casts a shadow. Some of the light may be reflected and some may be absorbed.

The most common effect of absorption is to change light energy into heat. This occurs because light energy may set electrons vibrating in a material. Heat is simply the kinetic energy of a substance. The more vigorously molecules move, the higher the temperature. Electricity may also be produced when light strikes certain materials in photovoltaic cells. The light energizes electrons so they fly off the material. So long as light is striking photovoltaic cells, electricity is produced. Light may also bring about chemical changes when striking certain materials. Generally light affects matter chiefly by acting on the outer electrons in atoms.

Light may also be transmitted through materials. Transparent substances absorb light and allow it to penetrate through the material. The color of light that is transmitted will give the transparent material its color. Translucent materials allow light to pass through but diffuse and scatter it on passing. Refraction occurs when a light ray enters a transparent material at an angle. The light appears to bend.

Gears

Gears are vital parts of modern machines. A gear is a wheel with teeth cut into its outer rim. When teeth of two gears are meshed together, one gear turns another. Each gear is connected to a shaft. One supplies the effort force and the other moves the resistance. Thus a pair of gears is like a wheel and axle.

The mechanical advantage of a machine indicates the number of times that a machine will multiply the effort force. Because of friction, the actual mechanical advantage will be less than the ideal mechanical advantage. If the mechanical advantage is three, this means that an effort force of 10 newtons is needed to lift an object of approximately 3 x 10 or 30 newtons weight. The mechanical advantage of a pair of gears depends on the number of teeth of each gear. If a gear of five teeth is connected to one with 20 teeth, the gear ratio is four to one. This means the smaller gear will turn four times for every revolution of the larger one. If an effort is applied to the smaller gear, the ideal mechanical advantage is four. A 25 newton force on the smaller gear will move a load of 100 newtons on the larger one. If one applied the effort force on the larger gear then the mechanical advantage would be ¼. Thus 100 newtons would be required to move a 25 newton force, but the load would move 4 times faster. Thus gears may decrease the effort force, speed up the load movement, or change the direction of motion.

APPENDIX: ADDITIONAL SCIENCE AND SOCIAL SCIENCE CONCEPTS (Continued)

Social Science

In order to appreciate the impact technology has on their lives, students need only consider the expanding role of computers in our society. The speedy analysis of, and response to, information has brought about numerous changes in our way of life.

The Unites States' adventures into space would have been impossible were it not for computers. Advances in computer-assisted X-ray scanning have provided valuable tools to diagnose illnesses. Modern offices use computers to perform office tasks such as record keeping, inventory control, payroll accounting, and billing. There are factories where computer-controlled robots do almost all the manufacturing tasks. In many homes, computers are used for entertainment, instruction, and word-processing.

The Computer Age is really just dawning. In the years ahead, consumers may never have to leave their homes to go shopping. Letters and newspapers may be sent and received through computer networks. Workers will need technical skills in order to function on the job. Almost every facet of our lives will be influenced by computer technology, for better or worse.

INTRODUCTION TO TECHNOLOGY TECHNOLOGY LEARNING ACTIVITY

CLEAN THE AIR

MODULE NUMBER: T-10
NUMBER OF DAYS: 30

MAJOR CONCEPTS TO BE ADDRESSED

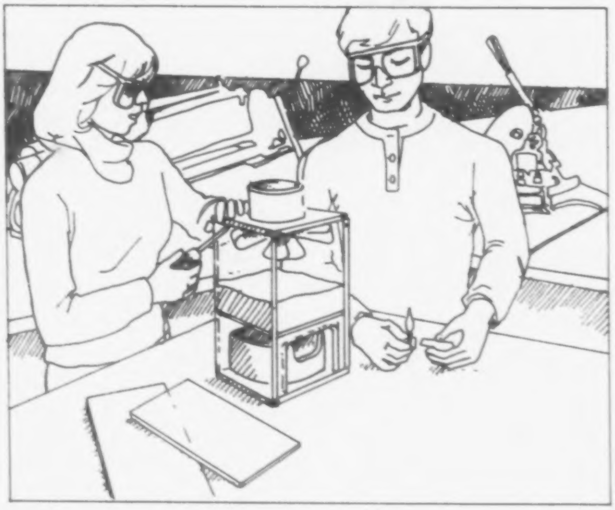
T-10A The same systems model which is used to diagram individual technologies is an effective problem-solving tool.

T-10B The solutions to practical problems often involve a combination of subsystems from different aspects of technology.

T-10C Computers, as tools, can be used to store and retrieve information.

T-10D Computers are tools which may be used by people to help decide upon a solution to a problem as well as to implement a solution to a problem.

OVERVIEW OF TLA



This activity illustrates how a student can choose a problem and model a technological solution. In this instance, the problem is the need to clean the air. Using the systems diagram as a problem-solving tool, students will apply the knowledge gained through the previous Technology modules to design an open-loop and a closed-loop system to remove air pollution from a room. Sensing devices that form subsystems will be combined to form a more effective system. Computers will be used to process data and make a more informed decision. Suggested technological processes include a ventilation and/or an air filtration system, with smoke and heat detectors used as monitors. "Hands-on" activities include designing and constructing an automatic ventilation system, an air filtration system, and a smokeless ashtray (see Appendix: Diagrams). Students will discuss the impact of technology in preventing health problems through the use of indoor ventilation.

EQUIPMENT AND SUPPLIES

- Smoke detector (e.g., ionization monitor, photoelectric detector)
- Heat sensor
- Fan (e.g., table or window fan, battery or spring driven fan)
- Materials for ventilation ducts (e.g., metal sheeting hose, plastic)
- Filter materials (cigarette filters, paper, room air filters, etc.)
- Screening for filter mount
- Duct tapes and brackets
- Feedback, Inc. PZ-10 and one LED

PROCEDURE FOR THIS ACTIVITY

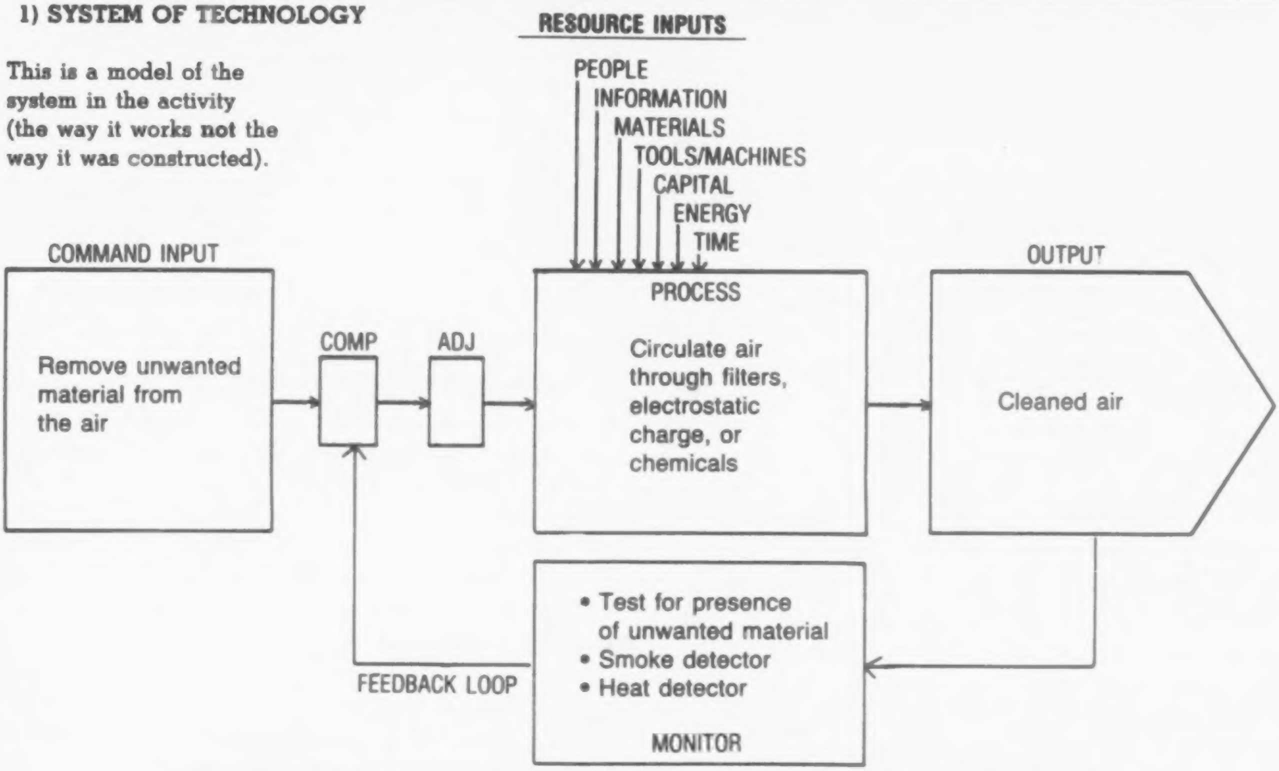
Days	POs*	Teacher Activity	POs*	Student Activity
1	1a-g	Introduce the idea that both a systems diagram and formalized problem solving must include input, process, and output. Show the similarity of the systems diagram and formalized problem solving.	1a-g	Identify input, process output, and monitor. List criteria for comparing input and output. Propose possible adjustments.
2	PO1	Propose sample problems in each aspect of technology. (Include cleaning the air.) Use Figures 1-4 in Appendix: Diagrams for ideas.	PO1	Draw a systems diagram which depicts the systems approach to developing a solution to a problem.
3	2b	Discuss local air pollution problems. Provide information on feedback techniques that are incorporated in existing ventilation systems. (Assign one or more problems for further research.)	2a-c	Develop drawings, system diagrams, and problem-solving solutions to cleaning the air.
2		Discuss how air cleaning technology lessens health and safety hazards. (Assign two worksheets. See Appendix.)		Identify health hazards pertaining to particular jobs. Rework solutions to reflect safety and health. Do worksheets on Health/Safety and Technology at Home.
16	2d	Demonstrate tools, equipment, and procedures for safe assembly of air filtration systems. Provide electronic systems needed for feedback.	PO2 3a-c	Construct air filtration system. Check using systems diagrams. Record resources, processes, and technical data. Test and refine system.
4	3e	Provide students with various computer software designed for record keeping.	3d 3e PO3	Use computer and selected software to store information related to air cleaning problem. Make a hard copy for future reference.
1	PO1	Discuss technology as a means of protecting all life forms from pollution, related diseases, and safety hazards. Provide data on agencies involved protecting the environment and people.	PO1	Record information and investigate agencies actively involved in local issues. Use problem-solving systems diagram to show the progress, or lack of it, toward the solution of a local problem.
1		Cover transfer of learning topics. Review for test on curriculum content.		Take test.
30 Total Days				

*See Syllabus for phrasing of performance objectives and supporting competencies.

CONSTANTS FOR INFUSION INTO THE TLA

1) SYSTEM OF TECHNOLOGY

This is a model of the system in the activity (the way it works not the way it was constructed).


RESOURCE INPUTS
PEOPLE
INFORMATION
MATERIALS
TOOLS/MACHINES
CAPITAL
ENERGY
TIME
COMMAND INPUT
Remove unwanted material from the air
COMP
ADJ
PROCESS
Circulate air through filters, electrostatic charge, or chemicals
OUTPUT
Cleaned air
• Test for presence of unwanted material
• Smoke detector
• Heat detector
MONITOR
FEEDBACK LOOP

IDENTIFY THE ROLE OF THE FOLLOWING RESOURCES IN THE SYSTEM ABOVE:
PEOPLE, INFORMATION, MATERIALS, TOOLS & MACHINES, CAPITAL, ENERGY, TIME.

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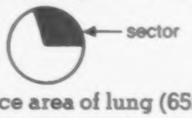
2) MATH - Use V = lwh to find cubic feet of air in room. Check fan specifications to determine cubic feet of air moved by fans. Find air exchange per hour when using a particular fan.

$$\text{air exchange of room in minutes} = \frac{\text{cubic feet of room}}{\text{cubic feet per minute of fan}}$$

Divide by 6 to get air exchange per hour.

Make cones by removing different size sectors from a circle. Use measurement and geometric figures to design and construct ventilation system.



Use ratios to compare surface area of lung (65m²) to square meters of flow space in Technology classroom.

3) SCIENCE - The following topics should be covered when investigating air cleaning. (See recommended text* for reference.) It is important that the student at this level is exposed to the concepts and not the full math and high level science involved. The use of a Van de Graaff generator and a test tube full of smoke will graphically display electrostatic cleaning.

Weight of air - Boyle's law, Charles' law
Noise of systems - measured in decibels
Positive and negative air pressure of buildings
Air stratification due to temperatures
Shape of air ducts and perimeters
Room air movement
Micron size of particles - Micron = .001 millimeters, .6mm = 600 microns = approx. .004 in.
Impurities in air: solids, liquids, gases, bacteria

4) HUMAN & SOCIAL IMPACTS - Impact of undesirable effects of technology on indoor and outdoor air pollution will be discussed. The use of technology to solve these problems will be a primary focus.

5) COMMUNICATION SKILLS - Reading plans and diagrams. Making graphs or charts. Communication through oral presentation skills.

6) SAFETY AND HEALTH - Discuss recent findings of problems related to insulating buildings, radon emission, Legionaires disease, breakdown of synthetics, cloth, finishes, glues, and insulation.

7) PSYCHOMOTOR SKILLS - Psychomotor skills will be necessary for the hands-on construction of the ventilation and/or filtration system.

8) CAREER RELATED - Health and safety hazards for mechanics, health care workers, scientists, and musicians will be mentioned in video and in class discussion and projects.

9) CREATIVE PROBLEM SOLVING - Opportunities for creative problem solving will be provided by this TLA including: identification and definition of a problem, goal and criteria setting, generation of alternative solutions and recognition of limitations, optimization, testing and evaluation.

10) TRANSFER OF LEARNING - Investigate the most recent findings on tobacco smoke and on other sources of pollution that exist in our homes. At what temperature are heat exchangers efficient? What are the advantages and disadvantages of heat exchangers? Should air cleaning systems recirculate the air within the building? Discuss the pros and cons of extent of insulation versus the need for air exchange.

BACKGROUND REFERENCES AND RESOURCES

*Althouse, Andrew D., Turnquist, Carl H., and Bracciano, Alfred F. *Modern Refrigeration and Air Conditioning*. South Holland, IL: Goodheart-Willcox Company, 1975.

NIOSH/OSHA. *Safety and Health for Industrial/Vocational Education*. Cincinnati: U.S. Department of Health and Human Services, July 1981.

The following booklets are available from any local American Lung Association:

"Occupational Lung Disease: An Introduction" (ALA #3500)
"On the Job Respiratory Protection" (ALA #0683)
"Lung Hazards in the Work Place" (ALA #0210)

The following materials are available from the American Lung Association of Western New York, 766 Ellicott Street, Buffalo, NY 14203

"Occupational Health and Safety for Middle School and High School Students: An Instructor's Manual"

Videotapes:

"Health, Safety, and Technology"

"It's Up To You: Occupational Safety and Health"

EVALUATION

The teacher should develop a two component evaluation system to determine if the student understands: (1) performance objectives and (2) skills, attitudes, knowledge & safety related to the specific lab activity.

(1) EVALUATION OF PERFORMANCE OBJECTIVES (Examples)

1. Add a feedback loop to control the system given and identify the monitor, comparator, and adjustment. 2b, 2c, 1e
2. Reorganize a list of systems as to biological, physical, and information technologies. PO1
3. Draw a problem-solving system and identify the steps. 2a
4. Draw a systems diagram and list similarities with the drawing of the problem-solving system. PO1, 2a
5. Given a list of systems, label each as closed loop or open loop. 2-bc

(2) EVALUATION OF SKILLS, ATTITUDES, KNOWLEDGE AND SAFETY (Examples)

1. Sketch the development of a cone.
2. How many cubic feet of air can be moved per hour by a fan with a CFM of 120?
3. A litmus test of 5 is more acidic than 6. (T/F)
4. Explain how a temperature sensor can operate a fan.
5. Using a systems diagram, explain the operation of a smoke detector.
6. List three common household chemicals that people use and explain how to protect oneself from the hazardous effects.

APPENDIX: SUPPLEMENTARY INFORMATION

Occupational diseases are responsible for 162,000 deaths each year. These deaths are preventable if technology is used to control health hazards. Possible control measures include:

- substitution of safer materials
- enclosing or encapsulating the hazardous substance
- rotating workers to limit exposure
- adequate ventilation
- personal protective equipment (respirators, goggles, gloves)

The lungs are the primary route by which toxic chemicals come into our bodies (with skin contact and ingestion being the other routes of entry). If the air sacs in our lungs were unfolded they would contain approximately 65 square meters of surface area. Thus a focus on "clean air" is an appropriate means of introducing students to undesirable health effects of technology.

Many occupational health hazards cannot be seen or smelled. This TLA can be accomplished using three different types of monitors to detect hazards. A photoelectric smoke detector and an ionization smoke detector differ in sensitivity. An ionization monitor also may detect hydrocarbons, which are present in solvents.

One "undesirable" effect of an automatic ventilation system is that if the smoke is caused by a fire, the increased ventilation may feed the flames. Thus, a heat detector has been included in this system which would automatically turn off the ventilation system.

A variety of filtering material is available for student experimentation. These include replacement filters for room air cleaners, available in most drug stores. Other materials (e.g., cloth, paper) are also available for experimentation.

Everyone is a potential victim of health hazards while using technology at home, work, or play. Occupational illnesses are not limited to "blue collar" workers. Homemakers are potential victims through exposure to toxins in cleaning agents, pesticides, and other substances. Office workers may suffer from second-hand smoke, occupational stress, or back problems. Health care workers can be exposed to radiation or laboratory chemicals. Even business managers, who may not be directly exposed to health hazards, must learn a system to control health and safety hazards in order to protect their workers.

APPENDIX: DIAGRAMS

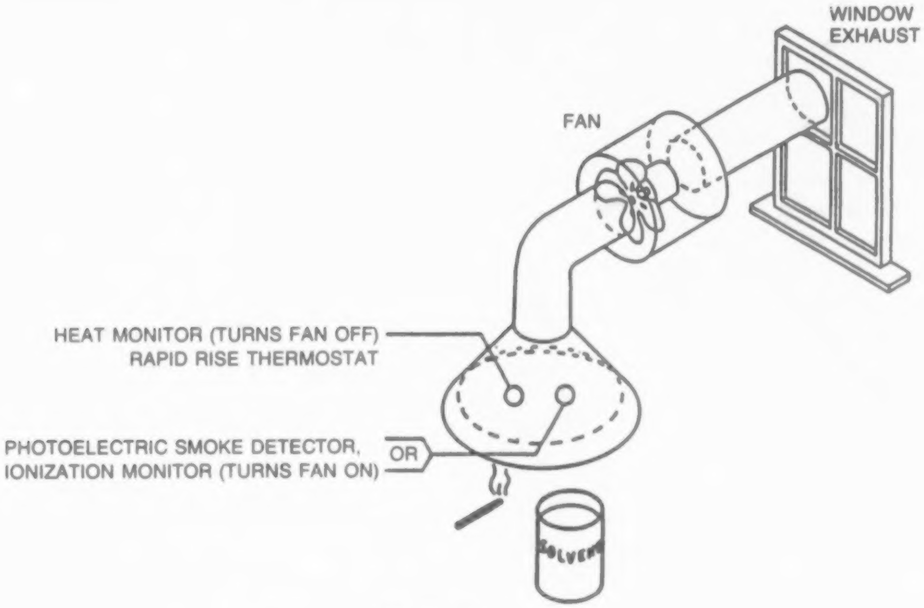

WINDOW
EXHAUST
FAN
HEAT MONITOR (TURNS FAN OFF)
RAPID RISE THERMOSTAT
PHOTOELECTRIC SMOKE DETECTOR,
OR
IONIZATION MONITOR (TURNS FAN ON)
SOLVENT

Figure 1

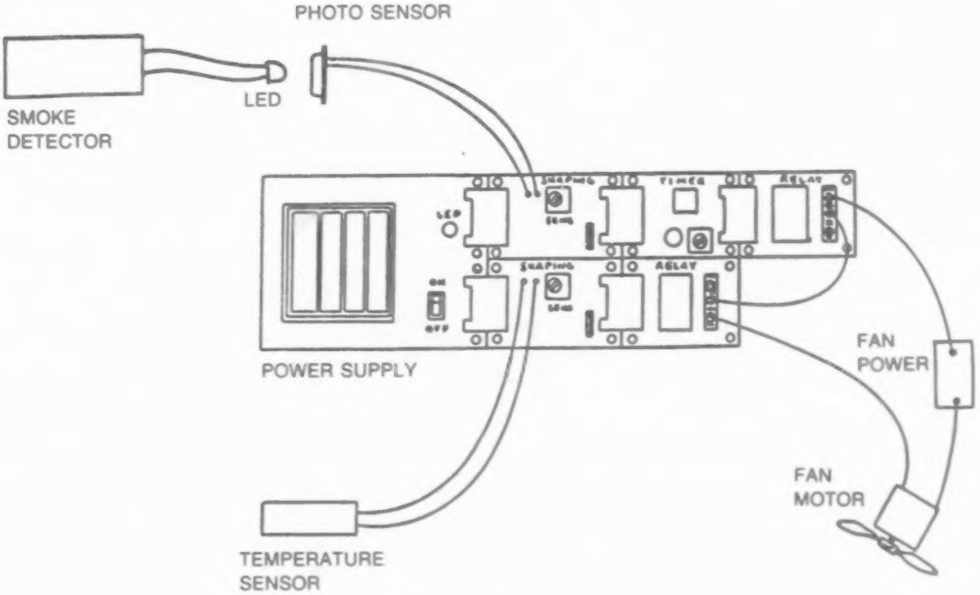


PHOTO SENSOR
SMOKE
DETECTOR
LED
LED
SHAPING
TIMER
RELAY
ON
OFF
SHAPING
RELAY
POWER SUPPLY
FAN
POWER
FAN
MOTOR
TEMPERATURE
SENSOR

Figure 2

APPENDIX: DIAGRAMS (Continued)

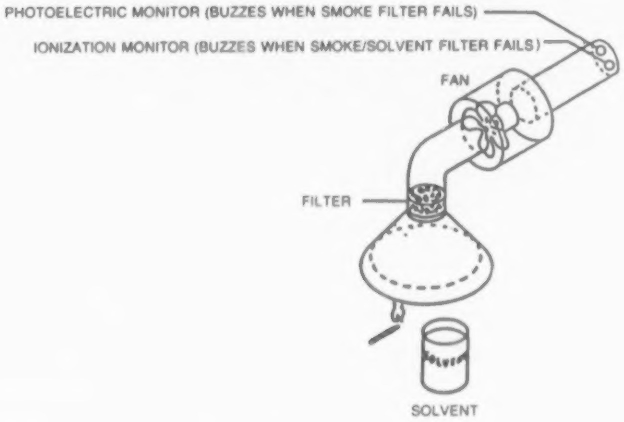

PHOTOELECTRIC MONITOR (BUZZES WHEN SMOKE FILTER FAILS)
IONIZATION MONITOR (BUZZES WHEN SMOKE/SOLVENT FILTER FAILS)
FAN
FILTER
SOLVENT
SOLVENT

Figure 3

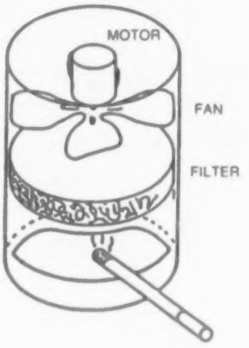
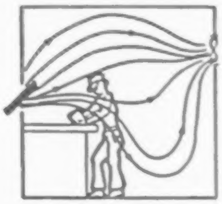

MOTOR
FAN
FILTER

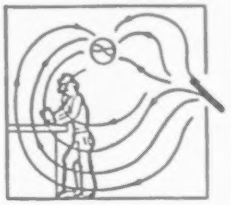
Figure 4

APPENDIX: GENERAL VENTILATION



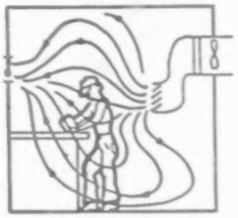
Poor General Ventilation

(Contaminant is driven into the worker's breathing zone and atmosphere)



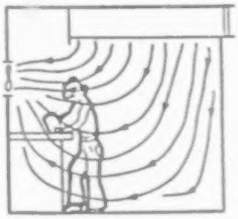
Fair General Ventilation

(Incomplete flushing of the room, contamination of general atmosphere)



Good General Ventilation

(Air enters at breathing zone height and keeps contamination away from worker)



Best General Ventilation

(Low velocity diffusion through ceiling, immediate exhaust of contaminated air)

APPENDIX: INDUSTRIAL/VOCATIONAL OPERATIONS AND THEIR ASSOCIATED HEALTH HAZARDS

Abrasive Machining. An abrasive machining operation is characterized by the removal of material from a workpiece by the cutting action of abrasive particles contained in or on a machine tool. The workpiece material is removed in the form of small particles and, whenever the operation is performed dry, these particles are projected into the air in the vicinity of the operation.

Ceramic Coating. Ceramic coating may present the hazard of airborne dispersion of toxic pigments plus hazards of heat stress from the furnaces and hot ware.

Dry Grinding. Dry grinding operations should be examined for airborne dust, noise, and ergonomic hazards.

Forming and Forging. Hot bending, forming, or cutting of metals or nonmetals may have the hazards of lubricant mist, decomposition products of the lubricant, skin contact with the lubricant, heat stress (including radiant heat), noise, and dust.

Gas Furnace or Oven Heating Operations (Annealing, Baking, Drying, etc.). Any gas or oil fired combustion process should be examined to determine the level of by-products of combustion that may be released into the workroom atmosphere. Noise measurements should also be made to determine the level of burner noise.

Grinding Operations. Grinding, crushing, or comminuting of any material may present the hazard of contamination of workroom air due to the dust from the material being processed or from the grinding wheel.

High Temperatures from Hot Castings, Unlagged Steam Pipes, Process Equipment, etc. Any process or operation involving high ambient temperatures (dry-bulb temperature), radiant heat load (globe temperature), or excessive humidity (wet-bulb temperature) should be examined to determine the magnitude of the physical stresses that may be present.

Molten Metals. Any process involving the melting and pouring of molten metals should be examined to determine the level of air contaminants of any toxic gas, metal fume, or dust produced in the operation.

Open-Surface Tanks. Open-surface tanks are utilized by industry for numerous purposes: degreasing, electroplating, metal stripping, fur and leather finishing, dyeing, and pickling. An open-surface tank operation is defined as "any operation involving the immersion of materials in liquids, which are contained in pots, tanks, vats or similar containers." Excluded from consideration in this definition, however, are certain similar operations such as surface-coating operations and operations involving molten metals for which different engineering control requirements exist.

Paint Spraying. Spray painting operations should be examined for the possibility of hazards from inhalation and skin contact with toxic and irritating solvents and inhalation of toxic pigments. The solvent vapor evaporating from the sprayed surface may also be a source of hazard, because ventilation may be provided only for the paint spray booth.

Plating. Electroplating processes involve risk of skin contact with strong chemicals and in addition may present a respiratory hazard if mist or gases from the plating solutions are dispersed into the air of the shop.

Vapor Degreasing. The removal of oil and grease from metal products may present hazards. This operation should be examined to determine that excessive amounts of vapor are not being released into the shop atmosphere.

Welding—Gas or Electric Arc. Welding operations generally involve melting of a metal in the presence of a flux or a shielding gas by means of a flame or an electric arc. The operation may produce gases or fumes from the metal, the flux, metal surface coatings, or surface contaminants. Certain toxic gases such as ozone or nitrogen dioxide may also be formed by the flame or arc. If there is an arc or spark discharge, the effects of radiation and the products of destruction of the electrodes should be investigated. These operations also commonly involve hazards of high potential electrical circuits of low internal resistance.

Wet Grinding. Wet grinding of any material may produce possible hazards of mist, dust, and noise.

Adapted and reprinted from *Compliance Operations Manual*, U.S. Department of Labor, OSHA 2006, January 1972, pp.XIII-3-8.

APPENDIX: HEALTH AND TECHNOLOGY AT HOME

READ THE LABELS!

We use chemicals at home for many helpful purposes (e.g., cleaning, fertilizing plants). But are you and your family protected from **undesirable** health effects? Read the labels and find out!

Use this sheet to record the warning labels on three different chemicals that are used in your home:

Name of Product: ______________________
Active Chemicals: ______________________
Use of Product: ______________________
Health Warning: ______________________

Name of Product: ______________________
Active Chemicals: ______________________
Use of Product: ______________________
Health Warning: ______________________

Name of Product: ______________________
Active Chemicals: ______________________
Use of Product: ______________________
Health Warning: ______________________

APPENDIX: SAFETY AND TECHNOLOGY AT HOME

There are many ways that technology makes our lives better at home through heating, lighting, entertainment, etc. However, these same technologies may have undesirable effects on your safety and the safety of your family.

Use this sheet to write three ways technology is being used in your home and list possible **undesirable** effects on your safety:

Use of technology: ______________________________

Possible undesirable effect on safety: ______________________________

Use of technology: ______________________________

Possible undesirable effect on safety: ______________________________

Use of technology: ______________________________

Possible undesirable effect on safety: ______________________________

APPENDIX: ADDITIONAL SCIENCE AND SOCIAL SCIENCE CONCEPTS

Science

An air pollutant is any substance which reduces the quality of air you breathe. The main products of burning—water (H_2O) and carbon dioxide (CO_2)—are not classified as pollutants unless they are produced in huge amounts.

Major air pollutants outdoors include carbon monoxide (CO), nitrogen oxides (NO_x), hydrocarbons, sulfur dioxide (SO_2) and particulates (smoke, dust, and aerosols). These air pollutants may be produced in nature from volcanic eruptions, forest fires, lightning, and wind. Human beings also produce these air pollutants from combustion in power plants and homes, manufacturing processes in industry, and fuel consumption in transportation. People are concerned more about human made pollutants because these are produced where people live and work.

Air pollutants can be detected by special devices, which are based on the properties of the different pollutants. Solid particulates can be detected by electrostatic precipitators. In this process, particulates entering the precipitator are given a negative charge. They are then attracted to positively charged catcher plates (unlike charges attract). The catcher plates are examined to detect and measure the amount of particulates.

Gases can be detected in several ways. Certain carbon compounds such as carbon monoxide (CO) or hydrocarbons have special properties. Some metals, called catalysts, will speed up the reaction of gaseous carbon compounds with oxygen. This heat can make the catalytic wire glow brightly.

All gaseous compounds can be detected using the property that different gases absorb light differently. A spectrophotometer is a device that measures the light absorbed by different gases.

Nature can handle many air pollutants, but people are adding them at a faster rate than natural processes can handle. Burning produces a large percentage of the total air pollutants.

On the next page is a chart that summarizes information about air pollutants.

Inside air pollutants differ from outside air pollutants. They may be produced by tobacco smoke, chemicals used in cleaning, gases from cooking stoves, and building materials. These pollutant concentrations can be reduced by mixing them with outside air.

Source: *Isis: It's All Air*. Massachusetts: Ginn and Company, 1981.

Social Science

As a result of environmental activities in the 1960s, people came to realize that our treatment of the environment posed a serious threat to the public's health and well being. Major air pollutants including carbon monoxide, lead, and sulfur dioxide were poisonous chemicals that the American people were being subjected to. By the end of the decade, Americans were convinced that pollution was a serious problem.

In 1970 the Environmental Protection Agency was established and given the responsibility for controlling the systematic polluting of the environment. Also in 1970 the Clean Air Act (amended in 1977) was passed and established emission standards for cars and factories. It was estimated that in 1970, 74 million Americans were being exposed to air that did not meet the standards set forth in this legislation. Companies were forced to install devices in their smoke stacks to prevent the emission into the air of noxious gases.

Over the past 15 years significant progress has been made in improving air quality throughout the country. The quantity of pollutants escaping into the atmosphere has been reduced significantly. Yet, the problem has not been completely eliminated. The existence of acid rain indicates that we still have reason to be concerned. The negative effect acid rain is having on our ecosystem requires that it be controlled. State and local governments and our Canadian neighbors are all demanding that something be done by Washington to deal with this threat to our environment.

APPENDIX: ADDITIONAL SCIENCE AND SOCIAL SCIENCE CONCEPTS (Continued)

POLLUTANT	HOW FORMED	HOW CONTROLLED	EFFECTS ON HUMANS
PARTICULATES	Tiny particles of soot and dust from burning coal, wood, and other solids in mining operations and factories.	Filters and electrostatic precipitators collect particulates. Scrubbers pass dirty air through a water spray and dust particles collect in water drops. Settlers whirl dirty air causing the heavier particles to settle first.	Too many particulates overload and damage tiny cilia in the respiratory system, thus reducing the ability of cilia to filter out particles from the air.
CARBON MONOXIDE (CO)	A colorless, odorless, tasteless gas produced when there is not enough air for fuel to burn completely. Thus instead of producing carbon dioxide, carbon monoxide is produced.	CO is produced in cars. A solution to reducing CO is to use more air in the air-fuel mixture or to send unburned CO back to the burning chamber. Catalytic converters in cars can change CO to carbon dioxide (CO_2) in the following reaction: $2CO + O_2 \rightarrow 2\ CO_2$	CO is deadly to animals, keeping the body from getting oxygen needed for respiration. The hemoglobin in red blood cells carries oxygen to all body parts. Hemoglobin combines with CO about 200 times more readily than with oxygen. Headache, nausea, and death may result from reduction of oxygen to body cells.
HYDROCARBONS (HC)	Compounds of hydrogen and carbon. Gasoline, fuel oil, and natural gas are hydrocarbon compounds. Hydrocarbons get into the air by evaporation of fuels. They also are produced when fuels are not completely burned.	Evaporation can be controlled by using closed delivery systems. Incomplete burning of fuels in cars can be controlled in ways similar to those for CO. Burning hydrocarbons (HC) involves the reaction: $HC + O_2 \rightarrow CO_2 + H_2O$	Hydrocarbons are dangerous in high concentrations. They form a mixture with other pollutants which react with sunlight to form smog. The smog irritates and damages eyes and lungs and could cause lung cancer.
NITROGEN OXIDES (NO_x)	NO_x are formed when fuels are burned at high temperatures with lots of air. Air contains about 79% nitrogen and 20% oxygen. NO_x from the air around burning fuel combine to form nitrogen oxide pollution.	To control NO_x in cars, special catalytic converters decompose nitrogen oxides into nitrogen and oxygen. Generally, to reduce NO_x, lower the burning temperature and reduce the amount of air.	NO_x dissolve in water to produce an acid. If breathed, NO_x dissolve in the moisture in the nose, throat, and lung passages to form acids. These acids damage the tissues through which air passes to the lungs. The tissues swell and block breathing.
SULFUR DIOXIDE (SO_2)	SO_2 is produced when fuels containing sulfur impurities are burned. Generally, coal contains more sulfur impurities than oil, gasoline, or natural gas. $S + O_2 \rightarrow SO_2$	SO_2 can be removed by using fuels with less sulfur, removing sulfur from fuels before burning, or controlling SO_2 after burning by use of special filters.	SO_2 reacts like NO_x in the body. Combined with smoke and fog, SO_2 produces more concentrated acid, which is more damaging than NO_x.

INTRODUCTION TO TECHNOLOGY TECHNOLOGY LEARNING ACTIVITY

TELECOMMUNICATION SYSTEMS

MODULE NUMBER: T-10
NUMBER OF DAYS: 20-30

MAJOR CONCEPTS TO BE ADDRESSED

T-10A The same systems model which is used to diagram individual technologies is an effective problem-solving tool.

T-10B The solutions to practical problems often involve a combination of subsystems from different aspects of technology.

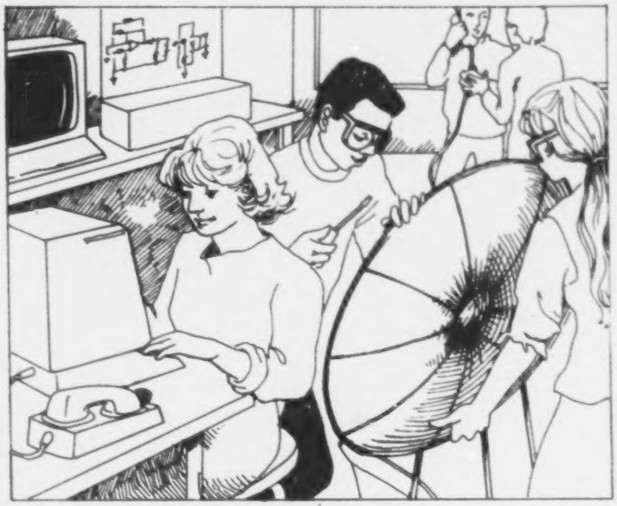
T-10C Computers, as tools, can be used to store and retrieve information.

T-10D Computers are tools which may be used by people to help decide upon a solution to a problem as well as to implement a solution to a problem.

OVERVIEW OF TLA

The purpose of this TLA is to provide the students with an opportunity to apply their knowledge of systems. Using the systems model as a problem-solving tool, students will determine solutions to practical problems and thus may create subsystems of the original system.

Students will be presented with the need to transmit a message over a distance. Students will work in small groups to assemble and use several telecommunication systems including traditional and historical systems and the CES Satellite System. In addition students will use a personal computer and modem to communicate with peers in another school and to access an information service such as Compuserve or Technet. They will also use the computer to record their progress during the activities and to help in comparing the methods of telecommunication they used.



EQUIPMENT AND SUPPLIES

- CES Satellite System, including:
  - transmitter station
  - receiver station
  - satellite
  - tape recorder
- Hand tools and machines
- Construction materials (wood, metal, plastic)
- Computer, modem, telephone line, software to maintain a database and for telecommunication
- Assorted materials to send messages by flags, cans and string, telegraph, etc.

PROCEDURE FOR THIS ACTIVITY

Days	POs*	Teacher Activity	POs*	Student Activity
1		Ask students to define communication and telecommunication. Describe the need for transcontinental communication. Have students propose alternative systems. Indicate that the systems should be fast and able to handle many messages, and that the cost per message must be low.		Provide definitions and participate in discussion. Suggest alternatives by using the brainstorming process.
	1a	Review the problem-solving model and its relationship to the basic systems model.	1a	Participate in discussion to relate the problem-solving model in Module T-3 to the basic systems model.
		Use the blackboard to record student list of communication-based problems in each of the three aspects of technology. Choose one or more of the suggested problems. Use the blackboard to draw and describe a systems diagram which depicts the systems approach to developing a solution to the problem(s).	1b-g PO1	Suggest problems in each of the three aspects. Select one problem in each aspect and draw and describe a systems diagram to: - describe command inputs - propose a process - list possible outputs - identify a method to monitor the outputs - compare the command input to the system output - describe ways of adjusting the system outputs.
2		Use blackboard and/or Technet transparencies to explain telecommunication using a computer and modem. Ask students to describe the equipment needed. (Note: see Appendix for recommended hardware and software.) Demonstrate how to: - log-on an information service such as Compuserve or Technet - navigate through the system - download desired information - output desired information to a printer - log-off the system - establish telecommunication between two personal computers.		Identify situations where a computer and modem based method of telecommunication is used. Identify and describe: personal computer, telephone and line, modem and software. Observe and participate in discussion during the demonstration.
1		Introduce the CES Satellite System. Identify and describe each component: tape recorder, transmitter, satellite, and receiver. Set-up each component and demonstrate use of the CES Satellite System.		Identify uses of satellite telecommunication. Participate in discussion about purpose of each component and relationship to actual satellite communication systems. Suggest suitable locations in the laboratory for each component.

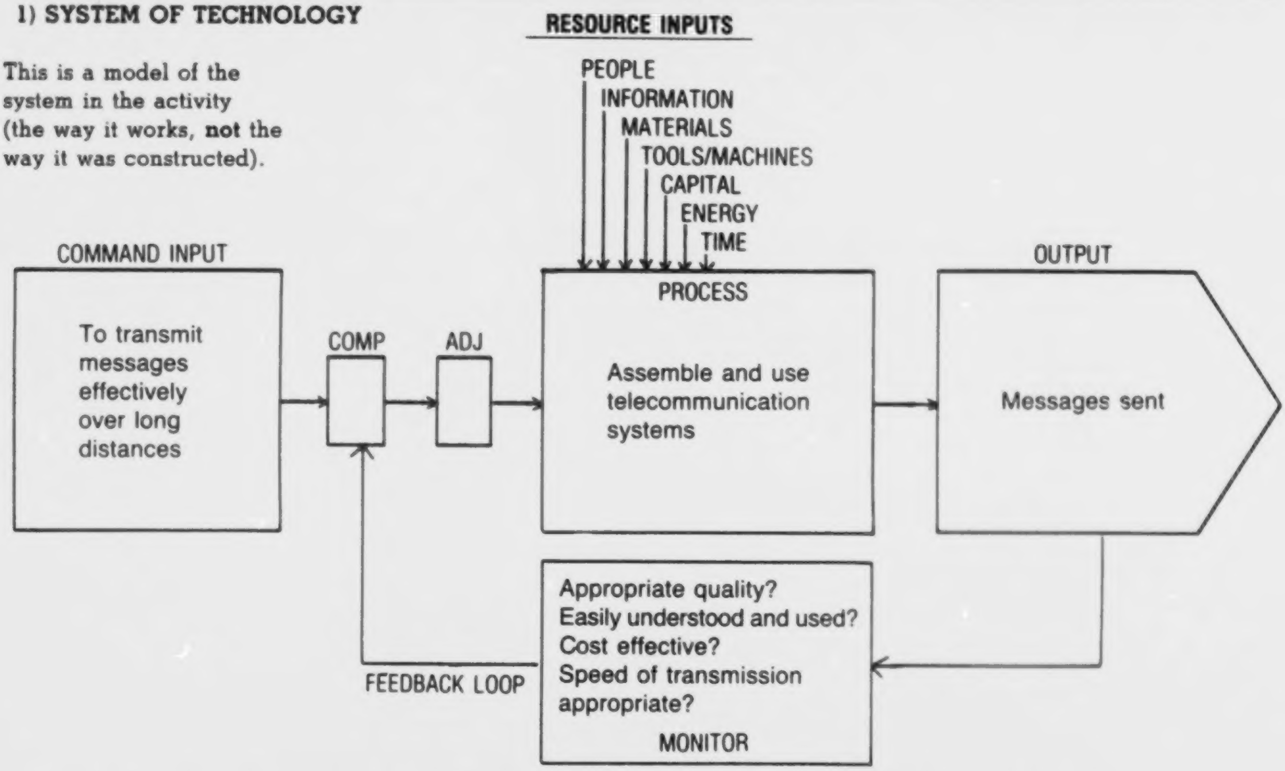
Days	POs*	Teacher Activity	POs*	Student Activity
1		Initiate a class discussion focusing on historic and traditional communication systems. Describe materials available for modeling these systems. Demonstrate safe use of the tools and machines that students will use.		Identify examples of the systems (e.g., drums, smoke signals, flags, telegraph, cups and string). Observe demonstrations.
11-21		Divide the class into project teams to work in the areas of: traditional and historic methods, computer-modem systems, and the CES Satellite System. Present the problem for each group:		Rotate in teams through activity stations. In one or more of the activities:
		1. Use materials in the laboratory to model two or more traditional or historic communication systems.	2a 2b	• Use a formal problem-solving approach. • Explain how several common systems are monitored and controlled by feedback.
		2. Use the computer and modem to download and print out information on an approved topic and compose and send an approved, three sentence message to a student in another school.		• Create block diagrams, sketches, and drawings of original technological systems that include the components necessary to monitor and control the system.
		3. Mount the CES Satellite in an approved location. Adjust locations of the transmitter and receiver to determine capabilities and limitations of the system. Record and send a one- to two-minute approved message.	2c PO2	Use materials, tools, instruments, equipment, and procedures to create an operating technological system. Design and develop a working closed-loop technological system.
3		Demonstrate using the computer as a record-keeping device. Assign each student to document progress toward reaching an optimal solution to one of the above problems.	3a-e	Record the resources used and list the technical processes. Record mathematical and other data. Analyze and record system output data. Use the computer and software to store information and data. Output the processed data to a printer or other recording device.
		As the activities of the TLA conclude, initiate discussion in which students use the data and information recorded to compare and contrast the various telecommunication systems.	PO3	Compare systems in areas such as cost, ease of use, speed, accuracy, etc.
1		Review and administer test on Module T-10.		Participate in review. Take exam.
20-30 Total Days				

*See Syllabus for phrasing of performance objectives and supporting competencies.

CONSTANTS FOR INFUSION INTO THE TLA

1) SYSTEM OF TECHNOLOGY

This is a model of the system in the activity (the way it works, **not** the way it was constructed).


RESOURCE INPUTS
PEOPLE
INFORMATION
MATERIALS
TOOLS/MACHINES
CAPITAL
ENERGY
TIME
COMMAND INPUT
To transmit messages effectively over long distances
COMP
ADJ
PROCESS
Assemble and use telecommunication systems
OUTPUT
Messages sent
Appropriate quality?
Easily understood and used?
Cost effective?
Speed of transmission appropriate?
MONITOR
FEEDBACK LOOP

IDENTIFY THE ROLE OF THE FOLLOWING RESOURCES IN THE SYSTEM ABOVE:
PEOPLE, INFORMATION, MATERIALS, TOOLS & MACHINES, CAPITAL, ENERGY, TIME.

2) MATH - Number codes for sending messages (Caesar's ciphers or those based on letter frequency). Compare methods of transmission of messages as to distance, cost, speed ($r = \frac{d}{t}$). Develop charts and graphs to present findings. Compare baud rates. Use trigonometric functions to calculate location of transmitter, satellite, or receiver.

3) SCIENCE - Geostationary orbits. Design and construction of satellites and launch vehicles. Electronics. Use of satellites for: communication, military use, weather forecasting, and detecting pollution. Energy conversion. Strategic Defense Initiative. Uses and advantages of fiber optics. Modem = modulator, demodulator.

4) HUMAN & SOCIAL IMPACTS - Communication satellites have helped make our world a global village. Faster communications affect the relationships between people. Consumer use of receiver dishes/antennas. Possible misuse of information contained in large databases.

5) COMMUNICATION SKILLS - Writing clear messages. Use of codes. Written and oral use of technical vocabulary. Use of schematic symbols and drawings to represent components and circuits. Use of the computer for telecommunication. Use of the computer to access information services such as Compuserve.

6) SAFETY AND HEALTH - Safe use of computers and other electronic equipment. Safe use of laboratory equipment to construct alternative communication systems. Rapid communication can alert people of impending emergencies (e.g., weather related) and save lives (e.g., summon medical aid).

7) PSYCHOMOTOR SKILLS - Develop or improve keyboarding skills, eye-hand coordination, and manual dexterity.

8) CAREER RELATED - Students will engage in activities related to careers in the fields of computers, communications, technical writing, engineering, and technical support.

9) CREATIVE PROBLEM SOLVING - Opportunities for creative problem solving will be provided by this TLA including: identification and definition of a problem, goal and criteria setting, generation of alternative solutions and recognition of limitations, optimization, testing and evaluation.

10) TRANSFER OF LEARNING - Application of problem-solving techniques to design systems to solve other technological problems.

BACKGROUND REFERENCES AND RESOURCES

Broderbund Software, 17 Paul Drive, San Rafael, CA 94903, (415) 479-1700. *Bank Street Filer*. Database program for Apple computers appropriate for students. A tutorial is included.

Bleazard, G.B., *Introducing Satellite Communications*. Manchester, England: NCC Publications, 1985.

CES Industries, Inc. 130 Central Avenue, Farmingdale, NY 11735, (516) 293-1420, (800) CES-LAB2 (NY), (800) CES-LAB1 (outside NY state).

Grolier Electronic Publishing, Inc., Sherman Turnpike, Danbury, CT 06816, (800) 858-8858. *The Information Connection*. Easy to use telecommunication program for Apple computers. A tutorial that enables students to learn about telecommunication before going on-line is an excellent feature.

____________. *Friendly Filer*. A database management system for Apple computers. A student tutorial is included.

______________. *Easy Graph*. A graphing program for Apple computers that enables students to create and print picture, bar, and pie graphs from data they collect.

New York Institute of Technology, Advanced Systems Lab, Northern Boulevard, Old Westbury, NY 11568. Technet telecommunications network for Technology teachers and their students.

"Resources in Technology: Satellite Communication," *The Technology Teacher*, November 1985, pp. 15-22. State Education Department. Transparency masters to explain the Technet computer and modem based telecommunication system.

Singleton, Loy A. *Telecommunications in the Information Age*. Cambridge, MA: Ballinger Publishing Co., 1983.

EVALUATION

The teacher should develop a two component evaluation system to determine if the student understands: (1) performance objectives and (2) skills, attitudes, knowledge & safety related to the specific lab activity.

(1) EVALUATION OF PERFORMANCE OBJECTIVES (Examples)

1. Given a technological problem, draw and describe a systems diagram for a possible solution to the problem. PO1

2. Demonstrate use of the computer to enter, store, retrieve, and output information. PO3

3. Explain, using an example, how a closed-loop system can be monitored and controlled. PO2

4. Describe how a computer can assist in the decision-making process. PO3

(2) EVALUATION OF SKILLS, ATTITUDES, KNOWLEDGE AND SAFETY (Examples)

1. Describe the evolution and impacts of several telecommunication systems.

2. Describe several uses of satellite systems (e.g., communications, security/surveillance, manufacturing, scientific data).

3. Describe how communication technology has helped to make the world a global village.

4. Assemble and operate several traditional telecommunication systems.

5. Assemble the CES Satellite System and send and receive coded messages.

6. Identify and describe the major components of a microcomputer-based telecommunication system.

7. Access a local bulletin board or database service and download information.

APPENDIX: CES SATELLITE SYSTEM

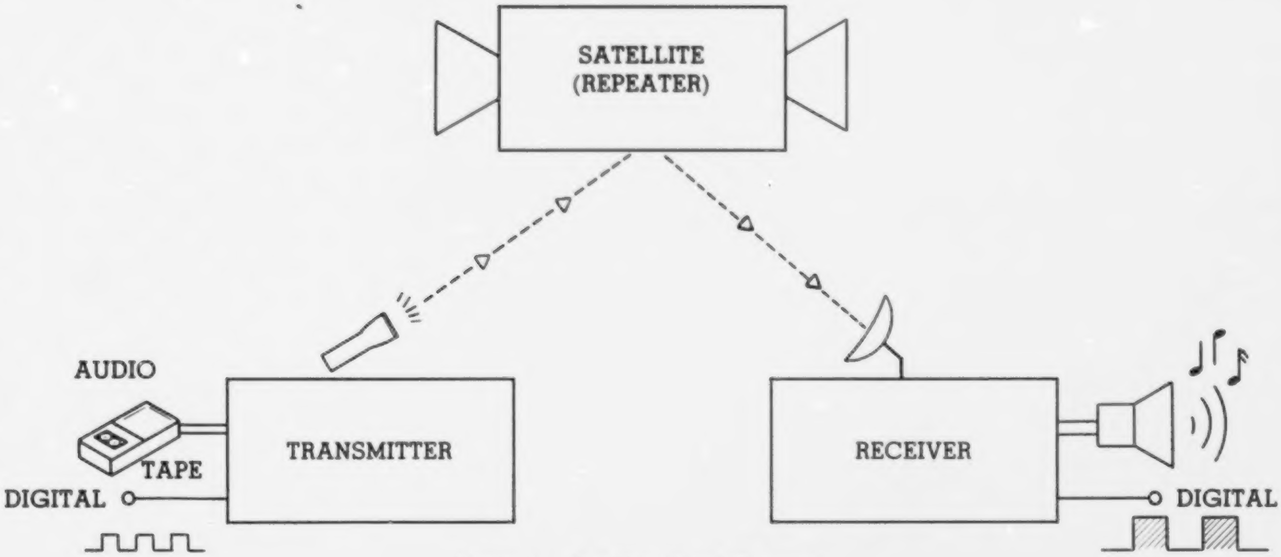


Figure 1 - Satellite Block Diagram

The CES SATELLITE SYSTEM CES 230 is composed of three basic components: a Transmitter Station (CES 205), a Receiver Station (CES 210), and the Satellite OPTO 4 (CES 213). This system is used to demonstrate the concept of satellite communications. The transmitter sends a signal to the satellite which is amplified and transmitted back to the receiving station (see Figure 1). The signal which is transmitted can be either an analog signal (audio) or a digital signal (binary 1's and 0's). These signals are transmitted by varying the intensity of a light beam. A description of each component follows.

TRANSMITTER STATION (CES 205)

The CES 205 Transmitter Station consists of a flashlight mounted on a black box with several switches and jacks. When the unit is plugged into an AC outlet and power is turned ON (red LED on), the flashlight will glow. The toggle switch located towards the center of the box is used to transmit digital data. When this switch is up, the green LED will glow and a 2000 cycle per second tone is transmitted over the light beam; this is interpreted as a logical "1" by the receiver. When the switch is down, the green LED will be off and nothing will be transmitted over the beam; this is interpreted as a logical "0".

Audio signals are transmitted by first connecting the earphone jack on the supplied cassette player to the phono jack on the transmitter station and then inserting a tape and pressing the play button.

CIRCUIT DESCRIPTION (See Figure 2a)

When the tape player is not connected to the circuit, the output of the Oscillator 1C drives the transistor which in turn drives the light. The transistor is used to amplify the current from the Oscillator 1C to a level which is capable of driving the flashlight. The digital switch is used to turn the Oscillator 1C on (switch up) and off (switch down).

APPENDIX: CES SATELLITE SYSTEM (Continued)

SATELLITE OPTO 4 (CES 213)

The OPTO 4 Satellite consists of a flashlight and phototransistor mounted on a PVC (plastic) cylinder. Power is supplied to this unit via an external A.C. adapter which plugs into a jack on the rear of the satellite. A toggle switch is also mounted on the rear and is used to select the mode, either up for sound (analog) or down for digital.

CIRCUIT DESCRIPTION (See Figure 2b)

The light received by the phototransistor varies the voltage at point A. This voltage, however, is not sufficient to drive the flashlight directly. The OP AMP IC is used to increase or multiply the input voltage to a level which is suitable for the flashlight. The OP AMP IC is a low power device and although it is capable of providing sufficient voltages, the corresponding current output is much too small for the flashlight. The output of the OP AMP drives a transistor which amplifies the current and drives the flashlight.

RECEIVER STATION (CES 210)

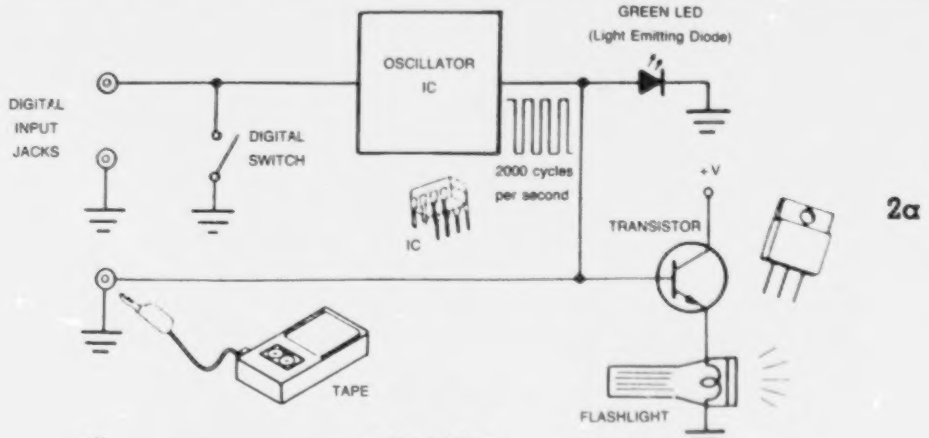
The CES 210 Receiver Station consists of a loudspeaker, satellite receiving dish, volume control, power switch, digital LED, and two banana jacks mounted on a black box.

To receive a signal, the satellite dish must be pointed towards the light source on the satellite. When the volume control is turned up approximately halfway and the receiver is properly aligned, the audio signal transmitted will be reproduced and heard over the loudspeaker.

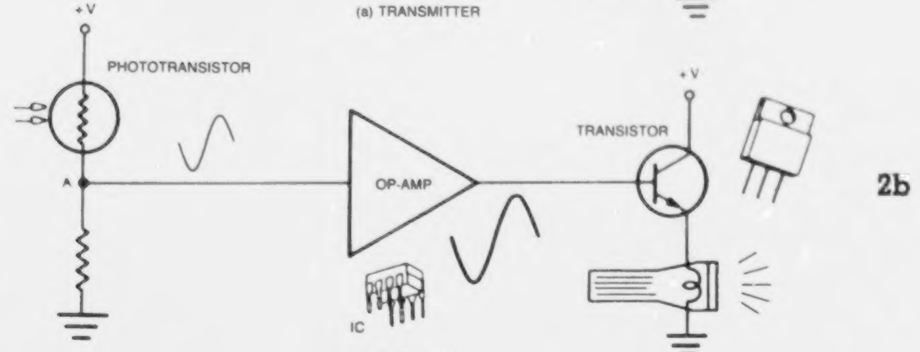
CIRCUIT DESCRIPTION (See Figure 2c)

A phototransistor is used to receive the incoming signal. The phototransistor is connected to the volume control which adjusts the input signal to the audio amplifier IC. This IC amplifies both the voltage and the current of the input signal to a level capable of driving the loudspeaker. The phototransistor is also connected to an OP AMP IC which amplifies the voltage to a level which will turn on the LED when a logical "1" is being transmitted. The digital output signals can be connected to logic circuits to display or print messages automatically.

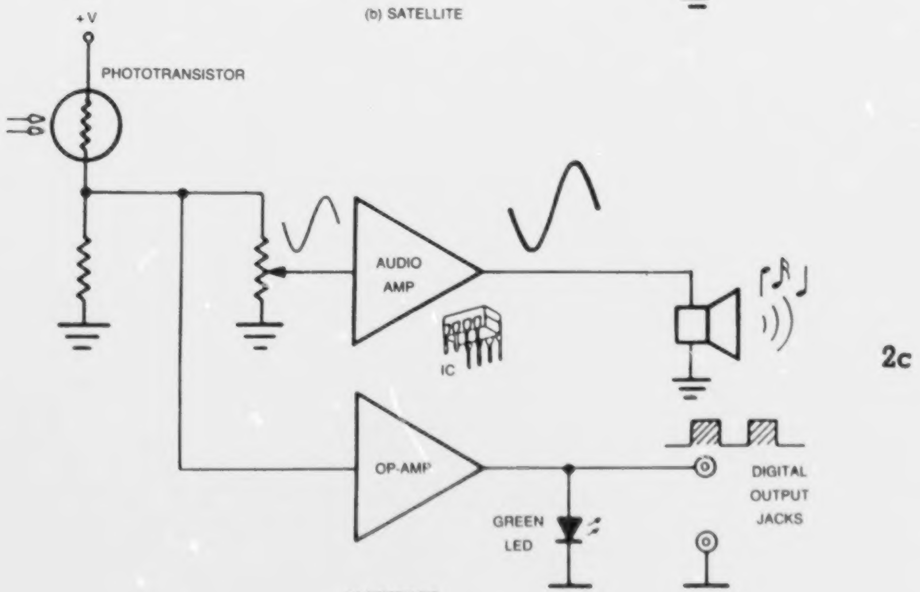
(NOTE: The schematic diagrams shown in Figure 2 are simplified; the actual circuits consist of more components than shown.)


GREEN LED
(Light Emitting Diode)
OSCILLATOR
IC
DIGITAL
INPUT
JACKS
DIGITAL
SWITCH
2000 cycles
per second
+V
IC
TRANSISTOR
2a
TAPE
FLASHLIGHT

(a) TRANSMITTER


+V
PHOTOTRANSISTOR
+V
TRANSISTOR
A
OP-AMP
2b
IC

(b) SATELLITE


+V
PHOTOTRANSISTOR
AUDIO
AMP
IC
2c
OP-AMP
DIGITAL
OUTPUT
JACKS
GREEN
LED

(c) RECEIVER

Figure 2 - Transmitter, Satellite, Receiver

APPENDIX: ADDITIONAL SCIENCE AND SOCIAL SCIENCE CONCEPTS

Science

Newton's three laws of motion are involved in achieving spaceflight of a vehicle.

1. First Law of Inertia states that a mass at rest tends to remain at rest and a mass moving at a constant velocity tends to keep moving at that velocity unless acted upon by an outside force.
2. Second law states that the acceleration of an object depends on its mass and applied force.
3. Third law states that for every action there is an equal and opposite reaction.

In order to achieve spaceflight, a space vehicle must overcome resistant forces: Earth's gravity and the drag (friction) of air through which the vehicle is moving. The inertia of the vehicle must also be ovecome.

The force of thrust is the force that opposes gravity, friction, and inertia. It is based on Newton's third law of motion. The gases escaping from the rear of the rocket cause the rocket to move in the opposite direction.

As a spacecraft rises, the force of gravity decreases since it is inversely proportional to the square of the distance between the objects. The air friction also decreases because air density is reduced at high altitudes. Thus, once in space, the thrust required to keep the vehicle moving becomes insignificant since now inertia of motion tends to keep the vehicle in motion.

Thrust can be reduced by taking advantage of the Earth's rotation, which is eastward, and launching the vehicle eastward.

To get a vehicle to revolve around the Earth requires that two forces be in balance: the force of gravity and the vehicle's centrifugal force. Since gravity decreases as altitude increases, the orbital speed will also decrease. Therefore a vehicle closer to Earth must go faster than one farther away. Johannes Kepler realized that as the distance from an object increases, the period of revolution increases. Kepler's Harmonic Law of Planetary Motion states $T^2 \propto R^3$ where T represents the time it takes a planet to make one complete revolution around its orbit and R represents the average distance of the planet from the sun.

A satellite must travel at a speed of about 8 km/sec (5 mi/sec) to remain in an orbit of about 240 km (150 miles) above the Earth's surface. At this speed the satellite circles the Earth in about 1½ hours. It is possible for a satellite to complete one revolution in 24 hours. This occurs at an altitude of about 36,000 km (about 22,000 miles). Since the Earth rotates once every 24 hours, the satellite's orbit will be synchronized with the Earth's rotation and the satellite therefore will not appear to move since the period of revolution equals the period of rotation. This type of orbit is called a geosynchronous or geostationary orbit and generally goes eastward around the equator. An advantage of this orbit is that properly placed satellites in geosynchronous orbits can be used to relay communications from one part of the Earth to other parts.

If satellites are launched at right angles to the equator, polar orbits occur. A polar orbit of proper altitude can pass over every part of the Earth's surface. Such a satellite can be used to observe the entire surface of the Earth.

By putting satellites in combinations of polar and geostationary orbits, useful results can be obtained in examining the Earth's surface and weather, and in facilitating global communications. Some uses of satellites are:

1. Exploring the Earth from space. Electromagnetic radiation travels through space in waves. Electromagnetic radiation has various wavelengths. Visible light forms a small part of the electromagnetic spectrum. Radio waves, microwaves, and infrared rays have longer wavelengths than light. Ultraviolet, X-rays, and gamma rays have shorter wavelengths than visible light. Satellites such as Landsat are equipped with sensors that can collect information on various kinds of electromagnetic waves coming from the Earth. For example, plants reflect infrared radiation strongly. The infrared sensors detect infrared radiation from vegetation accurately and radio the information back to computers on Earth. The computers process the information to show a picture of vegetation. Landsat images have been useful in determining the location of unknown oil and minteral deposits and changes in land due to fires and city growth.

APPENDIX: ADDITIONAL SCIENCE AND SOCIAL SCIENCE CONCEPTS (Continued)

2. Weather satellites. Satellites have been highly successful in improving weather forecasts. During daylight hours, satellites use visible light wavelength to send images, such as cloud formations, to receiving stations. At night satellite sensors may use infrared sensors to show cloud patterns or measure the temperature of the seas.
3. Telecommunications. Specially placed satellites in orbits can be used to facilitate worldwide communications. Radio messages from Earth could be relayed continuously to any part of the Earth by properly placed satellites, moving in geostationary orbits.

Social Science

Innovations in communications have historically brought people and their problems closer together. In the 19th century the inventions of Samuel Morse, Cyrus Field, and Alexander Graham Bell, to name a few, narrowed the distance between Americans, enabling them to talk to each other, send messages, and relay information more quickly, easily, and inexpensively than ever before.

Recent advances in technology have continued to "shrink" the nation and have advanced communication with the rest of the globe as well. Television enabled people not only to hear first hand what was happening in other countries but also to see events as they were occurring.

During the last two decades, communications satellites have accentuated the notion of a "global village." Radio waves, telephone calls, and television images can be bounced off satellites in space, allowing almost instant communication between any two points on Earth. Advanced communications systems have helped to change the relationship between nations. Leaders can quickly contact each other to resolve problems and discuss mutual concerns.

TECHNOLOGY LEARNING BRIEFS

The following pages contain ninety-nine ideas for students, so that they may investigate to find needed information, use that information creatively, and produce an optimal solution. The briefs vary in complexity to accommodate different student abilities. The instructor may desire to include some specific information to help students in their endeavors.

TECHNOLOGY LEARNING BRIEFS

1. **Problem:**
Persons who travel often cannot easily hang small articles of hand washed clothing to dry.

Brief and Constraints:
Design and build a mechanism for hanging clothes to dry when traveling. The device must fit into a 9"x 9"x 3" space, contain at least 10 lineal feet of hanging space, and support 15 pounds of wet clothing.

2. **Problem:**
Portable, compact devices to measure and determine average wind speed are not readily available for home users of wind power.

Brief and Constraints:
Design and build a wind speed indicator (anemometer) which is simple, effective, and durable that might be used by anybody wishing to assess nearby wind behavior. The anemometer must utilize a voltmeter or ammeter as the reading instrument.

3. **Problem:**
As a result of pressures to save both time and money, there is a need for new building designs which provide ease of installation and energy efficiency.

Brief and Constraints:
Design and construct a dome which may be closed or skeletal to span as large an area as possible supported only at the edges. The top of the dome must have a small, flat horizontal surface to hold weights to test the structure.

4. **Problem:**
Efficient use of materials in the manufacture and shipping of products has become a very important economic and environmental factor for most businesses. This results in the need to design packaging which is effective and economical.

Brief and Constraints:
Given a 12" by 20" piece of posterboard or a similar material, design and make a closed rectangular box to hold as many ½-inch marbles as possible. The box must also withstand breakage when dropped from a distance of one meter.

5. **Problem:**
Different operations along a mass production line in a factory often require varying amounts of time to complete. As a result, conveyor systems must often be sectioned with each portion moving at a different rate of speed.

Brief and Constraints:
Using Fisher Technik, Mechano, LEGO or a similar construction system, design and model a four section conveyor system. Each section must be of a different length and rate of feed. With the drive motors turning at the same speed, chart a relationship between the gear or pulley diameters and the lineal rate of speed.

6. **Problem:**
Poor aerodynamic design and construction along with other forms of mechanical deficiencies have traditionally plagued performance of many transportation vehicles such as trains, boats, cars, and planes.

Brief and Constraints:
Design and construct a model boat, car, train, or airplane and employ a testing system to determine its aerodynamic efficiency and/or mechanical performance.

7. **Problem:**
The advent of many technological devices such as the automobile has made it important for the majority of people to have very good reflexes if the interactions between people and machines are to remain safe.

Brief and Constraints:
Design and construct a mechanical or electrical device which may be used to measure a person's reflex reaction time.

8. **Problem:**
Weather forecasting has become an increasingly important factor in our highly technological society. In order to more accurately predict the weather, many instruments have been developed to measure various atmospheric conditions. Two of these conditions, air pressure and atmospheric moisture, play an important role in accurate weather predictions.

Brief and Constraints:
Design and construct a simple hygrometer and a simple barometer. Calibrate each instrument and chart a relationship between instrument readings and weather conditions. Begin to predict weather based upon extracted information.

9. **Problem:**
The use of petroleum-based products to power internal combustion engines will eventually become impossible as petroleum energy reserves are depleted.

Brief and Constraints:
Design an engine that will run using the unlimited resource of gravity.

10. **Problem:**
Standard paper envelopes can only be used once and then must be discarded, a wasteful practice.

Brief and Constraints:
Design an envelope that can be used at least two times before it is thrown away. Each time it is used it must be tightly sealed, using a conventional adhesive.

11. **Problem:**
Hearing-impaired persons are without the ability to respond to conventional doorbells, car horns, sirens, or other audio warning signals.

Brief and Constraints:
Design an alternative warning system for a hearing-impaired individual, which may be used in a specifically determined situation to alert the person.

12. **Problem:**
It is not always desirable, or even possible, for switching mechanisms to be operated manually. For reasons of safety, efficiency, and economy, switches are often activated by alternative sources.

Brief and Constraints:
Devise a switching system to be actuated by light, sound, heat, or timer. The switch must be used to activate a mechanical instrument.

13. **Problem:**
Environmental noise often interferes with student ability to concentrate on tasks at hand.

Brief and Constraints:
Model a way in which a person can reduce or eliminate unwanted sound. The solution must apply only to the person utilizing the sound-reducing technique.

14. **Problem:**
Current methods of removing seeds or cores from certain fruits are costly and inefficient.

Brief and Constraints:
Design and construct a cost-effective device which is capable of removing cores from an identified fruit.

15. **Problem:**
Material waste of all kinds is a serious problem in our society. A very small, yet excellent, example of material waste is the practice of discarding short ends of wooden pencils despite still usable graphite.

Brief and Constraints:
Design and model an instrument which would allow a student to use a pencil comfortably until it has been almost completely consumed.

16. **Problem:**
Due to poor design and/or implementation of traffic control devices, safety at certain road junctions is unsatisfactory.

Brief and Constraints:
Design a new layout and control system to make a given intersection safer.

17. **Problem:**
Many technological devices produce extreme noise. Aircraft, stereo sound systems, and manufacturing equipment are several items which may produce harmful effects under conditions of prolonged exposure.

Brief and Constraints:
Using a microphone and decibel meter, determine areas in your environment where constant noise is excessive. Assemble a descriptive presentation of the conditions by using charts, maps, interviews with individuals, and noted environmental conditions.

18. **Problem:**
Standard rulers or meter sticks are very inefficient in some applications where the basic unit of measurement is something other than a centimeter, meter, inch or foot.

Brief and Constraints:
Identify an occupation in which the performed tasks rely upon using an uncommon unit of measurement, e.g., bricklayer. Design and make a measurement template for a specific application within the identified occupation.

19. **Problem:**
Home gardeners and farmers expend wasteful amounts of time when planting various types and sizes of seeds.

Brief and Constraints:
Design an automatic seed dispenser which will handle various sizes of seed and is capable of sowing seeds at different rates.

20. **Problem:**
Many of the design principles used for making a die are similar when transferred to different material categories. Often similar or identical objects can be made out of more than one material.

Brief and Constraints:
Design and form a die for the production of an object of your choice, to be made from ceramic, plastic, metal, or a composite material.

21. **Problem:**
Motorists sometimes find themselves stranded on dark, rainy nights without a safe, convenient source of light with which to inspect a problem.

Brief and Constraints:
Design an electric lamp and holder for use in a damp, external position, to be electrically safe, weatherproof, durable, and easily attached to a wall or the hood of the car.

22. **Problem:**
Some packaging designs have traditionally been very awkward and inefficient. One example of this is the dispensing top of most polyvinyl glue bottles. School children often screw the top completely off because dried glue blocks the opening. Many of the dispensers do not distribute the glue in a fine line.

Brief and Constraints:
Design and make a durable, low-cost glue dispenser which gives a narrow flow and does not get blocked.

23. **Problem:**
The destruction of old buildings is an extreme waste of building materials, many of which are becoming scarce and increasing in cost.

Brief and Constraints:
Design and model a device that will prepare building bricks or construction blocks for re-use by chipping off the hardened mortar without causing damage to the block.

24. **Problem:**
In situations involving international travel, directions and signs which are written using text are often useless, due to illiteracy or visual disorders.

Brief and Constraints:
Design a way of communicating a message visually without using formal written language. The message should be understandable by all people.

25. **Problem:**
Water supply contamination is a very serious concern as the world's population grows and fresh water supplies diminish. Avoidable accidents causing contamination must be prevented.

Brief and Constraints:
Design and model a one-way valve which will allow fresh water to flow in one direction from a line, yet prevent a reverse flow of contaminated water into the line under a reversed pressure situation.

26. **Problem:**
Adjusting the chain length on a chain driven vehicle, such as a bicycle, is a difficult task because of the problems encountered while removing retaining pins.

Brief and Constraints:
Design and make a tool which will be efficient and easy to use in the removal of drive chain retaining pins.

27. **Problem:**
Persons confined to wheelchairs often desire to participate in leisure time activities that many other people find to be enjoyable.

Brief and Constraints:
Design and make an object which will make it easier for a person in a wheelchair to participate fully in an activity.

28. **Problem:**
An automobile mechanic has a hand completely severed in an accident, yet still wishes to continue work as a mechanic.

Brief and Constraints:
Design and model a device to attach to the mechanic's arm which will securely hold most general mechanic's tools.

29. **Problem:**

Often, greenhouse farms are too large for manual ventilation control. Proper ventilation may necessitate the opening and closing of roof vents many times during a day to overcome heat or other atmospheric extremes.

Brief and Constraints:

Design a system to control and operate the roof vents in a large greenhouse complex.

30. **Problem:**

Black, asphalt-based roof shingles often absorb the summer sun's heat to create a very high temperature in the house.

Brief and Constraints:

Model a system to be automatically controlled by temperature which will cool the roof area of a home by utilizing the process of evaporation.

31. **Problem:**

Newly developed synthetic materials are being marketed without an acceptable amount of readily available consumer information.

Brief and Constraints:

Select a relatively new material or product and design a method or device to test for one or more of the following characteristics: safety, toxicity, elasticity, flammability, and hardness.

32. **Problem:**

Technological monitoring devices perform many important functions. A heart patient using a bicycle for aerobic rehabilitation or an engineer testing the durability of a new bearing design might need to monitor the revolutions of a wheel to assess the attained progress.

Brief and Constraints:

Design and make a device for counting the rotations of a bicycle wheel.

33. **Problem:**

In a fish hatchery, young fish have to be kept in constantly flowing fresh water.

Brief and Constraints:

Design a system based upon pumps and switches which will maintain a flow of water in a tank by partially draining water on a periodic cycle. Overflow must be prevented.

34. **Problem:**

Almost every powered appliance used at home, work, or during leisure activity relies upon some electrical circuitry. Unfortunately, many people don't have the knowledge or equipment to troubleshoot simple electrical circuit failures.

Brief and Constraints:

Design a simple, compact, and flexible circuit tester to test for broken wires, blown fuses, or other failed components in a circuit.

35. **Problem:**

Some people have difficulty in picking up objects from the floor.

Brief and Constraints:

Design and make a hand-held device which can be used to pick up items from the floor, without the need to bend down.

36. **Problem:**

A visitor to your school may have difficulty in reaching his or her destination.

Brief and Constraints:

Develop an aesthetic yet effective guidance system to help first-time visitors find their way around your school.

37. **Problem:**

The evolution of new kinds of music has often been accompanied by the technological development of new instruments.

Brief and Constraints:

Make a simple musical instrument on which a person can play a popular tune. The concept of sound based upon frequency of material vibration, or use of a column of air, must be incorporated and explained.

38. **Problem:**

The presence of undesired friction has long been an obstacle to the development of more efficient modes of transportation.

Brief and Constraints:

Design a self-contained working model of a vehicle which travels on a layer of air.

39. **Problem:**
Sometimes companies make a single product available in a choice of colors. At the manufacturing site, it is often necessary to sort the products according to color.

Brief and Constraints:
Design and make a mechanism which will automatically sort different colored balls of the same size and material.

40. **Problem:**
It is often necessary to attach dissimilar materials to each other for some specific application. Wood and glass or metal and ceramic are some examples. Many times a mechanical fastener must be devised since common adhesive properties do not exist.

Brief and Constraints:
Design a mechanical fastener which can be used to connect two different materials to each other.

41. **Problem:**
Children's toys often include some rather advanced mechanisms. When these toys break, they may very well be discarded for lack of understanding about how they work.

Brief and Constraints:
Design and make a 3D jack-in-the-box pop-up toy which includes a hitch, a catch, and a way to make the figure pop up.

42. **Problem:**
Visual communication of the effects of pollution upon the natural environment is a powerful, yet seldom utilized technique.

Brief and Constraints:
Develop a powerful 60-second video to encourage people to take an active role in stopping pollution.

43. **Problem:**
The invasion of outer space by human-made devices, such as communication satellites, space stations, and space travel vehicles, may create some unforeseen problems in the future.

Brief and Constraints:
Create awareness of the kinds of devices that are encircling the Earth by constructing a model of the Earth and the orbiting satellites and any space junk. Label each with the name of the country responsible for placing it into space.

44. **Problem:**
Many people have limited knowledge of the steps involved in the distribution and delivery of electrical energy from the source to wall outlets found in every home.

Brief and Constraints:
Design a working model which demonstrates all of the steps involved in the production and delivery of electrical energy. Begin with the generation of current and end with the illumination of a small lamp. Include transformers, transmission lines, and switches.

45. **Problem:**
Alternative energy sources have been neglected because of an already existing and very convenient power distribution network.

Brief and Constraints:
Based upon an assessment of local wind patterns, design and construct a working model of a wind-powered generating system which represents all of the major components needed for a full-scale domestic application.

46. **Problem:**
Heat from the hot water tank, furnace, and/or fireplace is often lost through the chimney. The waste of energy is considerable.

Brief and Constraints:
Design and model a method by which the normally lost heat is recovered for alternative domestic use.

47. **Problem;**
Because of tradition and/or convenience, the way that many tasks are performed never varies or improves. Holes are usually made with drills, boards are usually cut using a saw, and nuts and bolts are usually removed with wrenches.

Brief and Constraints:
Select an operation usually perfomed by using a conventional method or tool, and design an alternative way of achieving the same or similar results.

48. **Problem:**
In many places throughout the world, wind is constant, yet is used very little as a direct source of power for transportation.

Brief and Constraints:
Design and model a wind-energy harnessing device which may be used in conjunction with a current mode of transportation on land, at sea, or in the air. The net result should be greater efficiency.

49. **Problem:**
As electrical power shortages become more common, people must begin to turn to alternative sources of electrical power.

Brief and Constraints:
Design and model a device which will provide a supplemental power source to generate electricity. Locally available natural resources must be used.

50. **Problem:**
Many household chemicals are potentially dangerous if mixed with each other. Because of packaging, convenience, and lack of fundamental knowledge, these products are often stored and handled in a careless manner.

Brief and Constraints:
Closely inspect the labels of household chemicals throughout your home and prepare a chart with guidelines for their safe storage and use.

51. **Problem:**
Single compartment garbage recepticles are commonly used throughout the home. This results in the mixture of glass, food, plastic, paper, and metal in one container and limits the possibility for optimum recycling.

Brief and Constraints:
Design and model a waste container and compactor to be used in your home. The new container must occupy no more space than the old one, and must provide for the separation of different types of waste materials.

52. **Problem:**
People who jog or walk for exercise often have difficulty in correctly estimating the distance covered during the workout.

Brief and Constraints:
Design a counter to be mounted on a running shoe or sneaker which will accurately measure the distance that a person runs or walks. The device must not impede the user's natural movement.

53. **Problem:**
The automobile is a very inefficient method of transportation, in that each vehicle has its own individual engine as a power source, which uses a great deal of energy.

Brief and Constraints:
Model a multi-vehicle transportation system based upon vacuum or air pressure derived from a single power source.

54. **Problem:**
"Walkman" tape players sometimes do not have a means by which they may be attached to some part of your clothing, so that they do not need to be carried by hand.

Brief and Constraints:
Design an adjustable holder to fit any size or shape of compact personal stereo. Include a method by which it may be attached to some part of a person's clothing.

55. **Problem:**
Walking on ice during the winter can be very hazardous.

Brief and Constraints:
Design a method or device whereby on icy days, people may still wear conventional footwear, yet not have to worry about slipping on icy patches.

56. **Problem:**
In rural areas the post box is often quite far from the front door.

Brief and Constraints:
Design and model a system in which the mail in the post box can be retrieved during inclement weather without having to walk outdoors.

57. **Problem:**
Dry cells are generally useless after they have been drained of their energy reserve. As a result, they are thrown away.

Brief and Constraints:
Find and describe a way to recycle the materials in dead batteries.

58. **Problem:**
Parking a bicycle in a standing position is often difficult unless it rests on a flat and level surface.

Brief and Constraints:
Design a retractable bicycle stand that can be easily adjusted to support a standing bicycle on any terrain.

59. **Problem:**
Games often test such things as reasoning power, trivia facts, or spelling prowess. Very few, if any, popular games test or provide knowledge about biological functions.

Brief and Constraints:
Design a game to test and provide information about the function and identification of internal body organs.

60. **Problem:**
Various types of glues and adhesives, designed for very specific uses, are often misused.

Brief and Constraints:
Obtain several different brands and types of commercially available glues and adhesives. Test their properties when used as directed on a wide variety of materials over a wide range of applications. Test for properties under conditions of extreme heat, moisture, chemical exposure, force, and low temperature.

61. **Problem:**
Kinetic mechanisms often include mechanical components which effect change in direction of movement, changes in speed, and changes in power. Also included are changes in rotary motion and lineal motion.

Brief and Constraints:
Using Fisher Technik, LEGO, or a similar modeling system, construct a device that has components which change in direction of movement, include at least two and possibly three planes of operation, and convert rotary motion to reciprocal lineal motion.

62. **Problem:**
Tent stakes or small poles which have been anchored in hard ground for extended periods of time are somewhat difficult to remove.

Brief and Constraints:
Design a device to be operated by one person which will easily remove embeded stakes or poles.

63. **Problem:**
Windshield wipers often become ineffective when ice or foreign material adheres to or is lodged under the blades.

Brief and Constraints:
Model a way in which ice, snow, leaves, or other matter may be removed from the wiper blades without the driver's having to stop the car to remove the debris manually.

64. **Problem:**
Senior citizens may have difficulty trying to carry groceries or other articles up and down stairs.

Brief and Constraints:
Design and model a device to help people move shopping bags up and down stairs.

65. **Problem:**
Many devices such as slide projectors, stereo turntables, and fish tanks must rest on a flat, level surfaces to be operated.

Brief and Constraints:
Design and model a leveling stand capable of easy storage. Your design should include an adjustable tilt in two planes, adjustable vertical height, and be usable in various applications.

66. **Problem:**
Testing products for durability is an important part of development prior to any attempt at marketing a new item.

Brief and Constraints:
Design and make a device to lift a five pound object two feet vertically and then drop it, at which time the device retrieves the object and repeats the action.

67. **Problem:**
Weight distribution, traction, and power are all very important considerations in the design of safe, reliable recreational vehicles.

Brief and Constraints:
Design a model recreational vehicle which will climb an inclined surface under various conditions with optimum efficiency.

68. **Problem:**
When a clock alarm activates, it will continue to sound for an extended time if not manually switched off.

Brief and Constraints:
Design a device to switch off a clock alarm automatically after it has sounded for five, ten, or fifteen seconds.

69. **Problem:**
Hacksaw blades often break before the teeth become dull. Despite retaining a good cutting edge, the remains are often discarded.

Brief and Constraints:
Design a holding device to make use of a four inch or longer broken portion of a hacksaw blade which still has a good cutting edge.

70. **Problem:**
Innovative mechanical design is the basis of many new technological devices. Envisioning a mechanical operation and then making a prototype of it is an important process.

Brief and Constraints:
Design a "Mousetrap" type game where a marble starts a journey from a suspended point, travels through four different functions, and ends up in a box where it is carried to the top to begin a new journey.

71. **Problem:**
The wiring systems of home stereos and computers are often clumsy, unorganized, and difficult to troubleshoot if there is a problem.

Brief and Constraints:
Design a new method of making electrical connections between components in computers or stereos which will eliminate the current spaghetti configurations of wire.

72. **Problem:**
Birds have always been a source of great annoyance to gardeners.

Brief and Constraints:
Design an innovative device which uses solar energy to drive the birds from the fields.

73. **Problem:**
Aerosol can nozzles are difficult to operate by people who have advanced stages of arthritis.

Brief and Constraints:
Design a mechanism which will enable arthritis sufferers to operate any aerosol deodorant or shaving cream dispenser.

74. **Problem:**
Residential and hotel draperies should be made from fabrics that are flame-resistant. Some fabrics are more flame-resistant than others.

Brief and Constraints:
Obtain samples of natural and synthetic fabrics. Perform flame tests using a torch or bunsen burner. Determine which samples are flame-resistant and thus most suitable for draperies.

75. **Problem:**
During hot summer months, farm animals as well as household pets need a source of fresh water, yet it is not always possible to tend to their needs personally.

Brief and Constraints:
Design a spigot that will be operated by the approach of a dog, cat, cow, or horse which will refill a small water basin.

76. **Problem:**
Lifting physically impaired people between wheelchairs and automobiles or beds is often a difficult task.

Brief and Constraints:
Design and model a mechanism to lift a person from a wheelchair onto some other piece of furniture or into an automobile.

77. **Problem:**
Lightweight, but strong, plastic bags from local supermarkets are often discarded without any further use.

Brief and Constraints:
Design and make a kite, windmill, or aircraft using plastic bag material.

78. **Problem:**
People who travel through different time zones may have trouble remembering which time zone is in effect and adjusting their watches to the appropriate time.

Brief and Constraints:
Design and model a prototype watch face and hands which will help a traveler to know the correct time.

79. **Problem:**
Jewelry or other valuables made from precious metal are often dropped and lost outdoors, where it is difficult to find the lost items.

Brief and Constraints:
Develop a design and make a device capable of detecting metal objects which may be resting in a grassy area or buried in sand.

80. **Problem:**
Specimens of metal intended for specific applications must often be inspected to ensure that grain patterns are correct and that the material is free from defects. Lack of inspection might result in dangerous situations, such as building collapse.

Brief and Constraints:
Using successively finer grades of abrasive paper and some liquid polish, prepare speciments of several different types of metal to be inspected under a 40X or 80X microscope. Diagram on paper what you see and predict the material characteristics.

81. **Problem:**
Demonstrate the direct relationship that exists between electrical current and magnetism. That relationship is put to work in numerous technological devices ranging from automobile engine starters to electrical generators.

Brief and Constraints:
Design and make a solenoid to demonstrate the conversion of electrical energy to magnetic energy. Using the same solenoid and a magnet, demonstrate the generation of an electric current.

82. **Problem:**
The design and construction of a suspension system are the principal factors in ensuring safety, efficiency, and a smooth ride in an automobile.

Brief and Constraints:
Model and test suspension systems similar to various types found on automobiles. Record pertinent data related to suspension system behavior.

83. **Problem:**
Physically impaired people often have difficulty operating the switches involved in simple operations, such as turning a light on or off.

Brief and Constraints:
Design a sound activated switch to turn on and off a lamp or electrical appliance.

84. **Problem:**
New designs for the power systems used in airplanes, automobiles, trains, and boats must first go through testing before they are implemented in production.

Brief and Constraints:
Design and make a test rig to test and compare the pulling power, pushing power, or traction of vehicle drive systems.

85. **Problem:**
The danger of naturally occurring nuclear radiation is an important issue. Many people are unsuspecting of possible health dangers in their environment due to radiation.

Brief and Constraints:
Construct a simple Geiger counter, using a GM tube. Test several areas in which you often spend time for radioactivity.

86. **Problem:**
In one month, Earth intercepts energy from the sun equivalent to all of the energy stored in the total fossil fuel reserves in the ground. Despite this inexhaustable source of energy, solar power is largely ignored.

Brief and Constraints:
Construct a furnace to be operated using solar power. Use a parabolic collecting dish to complete the project.

87. **Problem:**
Humans are limited in their ability to recall precisely a specific happening, action, or natural phenomenon. In the case of the space shuttle disaster, only through viewing photographs and video recordings were experts able to determine the actual sequence of events.

Brief and Constraints:
Design and assemble a set-up for high speed photography. Photograph a rapid motion occurrence. Freeze from rapid motion the breaking of an egg or the impact of a falling water droplet, for example.

88. **Problem:**
Positive grip between road surfaces and tire tread is a constant concern of vehicle safety engineers. Low coefficients of friction and resulting slipping are the causes of many automobile accidents.

Brief and Constraints:
Using LEGO or a similar system, model various tire designs and road surfaces.

89. **Problem:**
Drivers sometimes run out of fuel when they fail to recognize the position of the indicator needle on the gas gauge.

Brief and Constraints:
Devise an alternative warning system to warn a driver of low fuel reserves.

90. **Problem:**
The moving of building materials around a residential construction site during building tends to disrupt the natural landscape and create very muddy and/or dusty conditions.

Brief and Constraints:
Design and model a compact, collapsible crane, which could be erected at any residential construction site, to move materials to any area without causing excessive disruption to the land.

91. **Problem:**
An ironing board is not efficiently designed to iron all types of clothing, e.g., long sleeves.

Brief and Constraints:
Redesign the shape of an ironing board for easier ironing of any type clothing.

92. **Problem:**
Despite the pruning of trees, many apples are out of reach of the workers who pick fruit at harvest time.

Brief and Constraints:
Design a device that is capable of reaching apples that are out of reach, high up in the tree. It must have a firm grip, yet not damage the fruit.

93. **Problem:**
A cat or dog is allowed to enter the house through a pet door. Other animals have also been using this door.

Brief and Constraints:
Design a device that will permit only your own dog or cat to enter or leave the house.

94. **Problem:**
Many times the metal that is cast into a mold does not completely fill the mold cavity. Because of rapid cooling, mold design, or air pressure, the casting is incomplete.

Brief and Constraints:
Devise a method and make a model which will overcome this problem to ensure a complete casting every time.

95. **Problem:**
There are many reasons why a device launched into the air or into space should return to its site of origination.

Brief and Constraints:
Design a device to be launched or sent into air travel which has a control component to return it to its original position.

96. **Problem:**
Used motor oil has been determined to be a carcinogen (a cancer-causing agent).

Brief and Constraints:
Design a safe storage container which will seal the oil against spilling and prevent the escape of vapors.

97. **Problem:**
Choosing the correct light bulbs can be a challenge because there are many types of artificial light devices available today. Incandescent bulbs and fluorescent tubes are two examples.

Brief and Constraints:
Obtain several different kinds of light bulbs and test for cost, comfort, efficiency, and durability.

98. **Problem:**
It is a misconception that solid, heavy, steel rods or beams are always needed to provide adequate support for specific applications.

Brief and Constraints:
Using only an 8 by 18 inch piece of #20 gauge sheet metal suspended between two concrete blocks, support two hundred pounds at least 8 inches off the floor.

99. **Problem:**
People in wheelchairs cannot enter and exit conventional swimming pools without assistance.

Brief and Constraints:
Design and make a model of a swimming pool which anyone confined to a wheelchair may enter and exit without assistance.